InBalance

Data Validation and Mass Balance
Module for Wonderware System Platform

User Guide
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InBalance Module

Overview

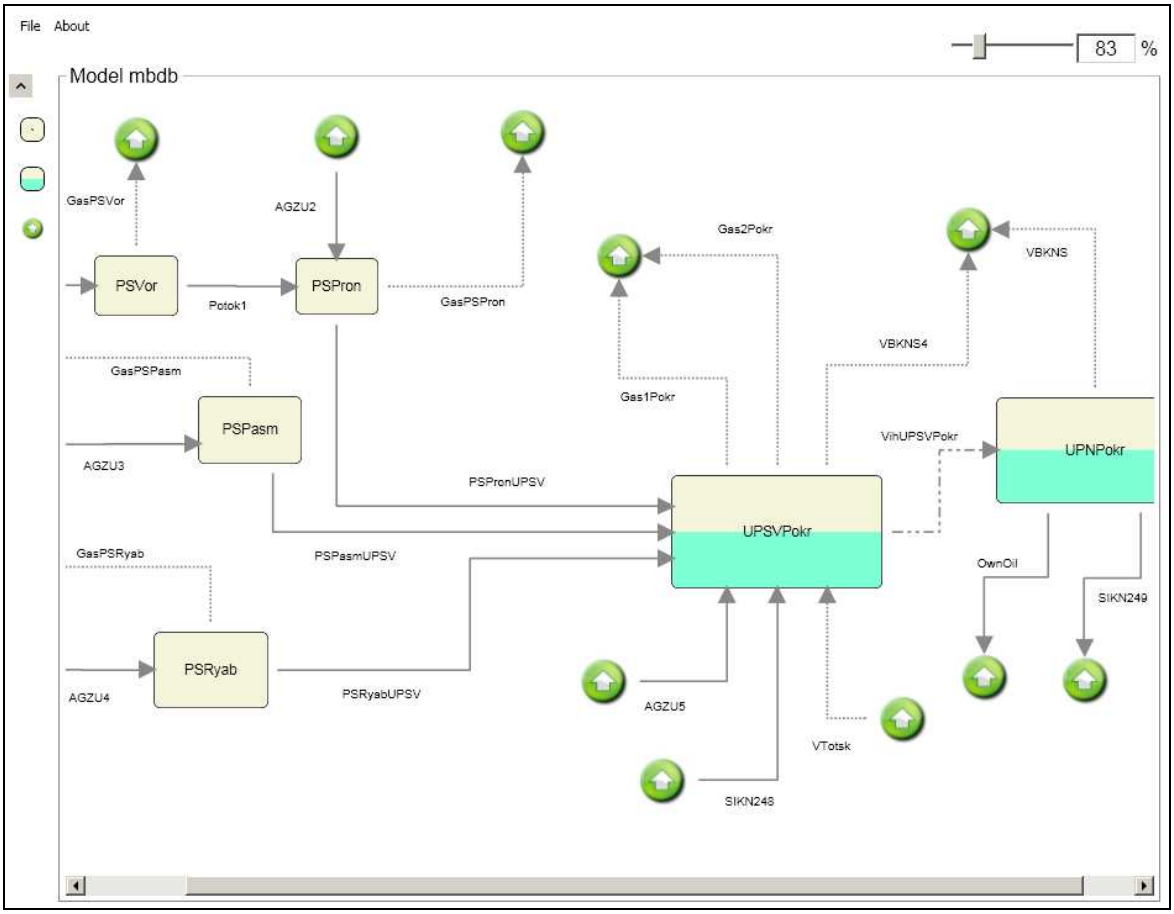
The Wonderware Finland **InBalance Module** provides a modular and integrated in Wonderware System Platform solution for data reconciliation/validation and mass balance calculation, allowing easy integration into existing and new projects.

The InBalance Module consists of two main parts:

- drawing tool (Model Editor),
- calculation part, implemented as Wonderware Application Server object.

The system model consists of units (called **nodes**) connected by **streams** of material. Typical nodes are technological facilities, tanks, apparatuses or their parts, connections or disjoins of pipes. Streams are process streams of material, characterized by flow rate.

For each project the “nodes/streams” system model is created by using a special **Model Editor**, implemented as Archestra Symbol containing .NET Control developed by using C# programming language. This .NET Control can be used in Wonderware InTouch or Application Server and allows to draw and create a model consisting of nodes and streams and configure their parameters:

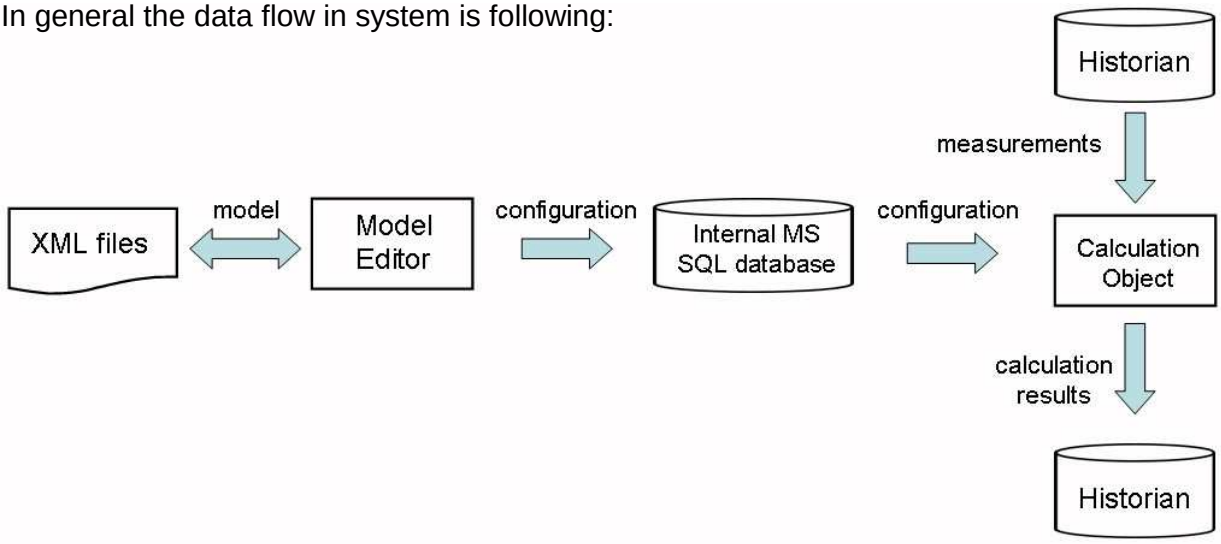


The data validation/reconciliation and mass balance calculation is performed by specially developed **Wonderware Application Server Object** (Calculation Object), where the following main tasks are performed:

- pre-processing and screening of input data to remove evident errors and mistakes;
- automatic data classification and determination of solvability;
- data reconciliation by using least squares method to calculate reconciled values and their confidence intervals and calculate the values that cannot be measured;
- checking of mass balance in purpose to find leakages, measurement errors or storages not defined in the model.

In this Calculation Object all current nodes and streams are implemented as object virtual primitives – one primitive for each node or stream. The results of reconciliation, configuration data and runtime information can be obtained by accessing the Calculation Object attributes.

In general the data flow in system is following:



The system model created in Model Editor is saved as .XML file and also written to internal MS SQL database, used as internal interface between Model Editor and Calculation Object.

The Wonderware Historian is used as a source of measured data – for each stream and storage (accumulation) node there is a “Historian tagname used to store measured data for this stream” attribute available.

The Wonderware Historian is used as a target place for reconciled/validated and balanced results for further reporting and data export.

Main advantages of using InBalance

InBalance offers several advantages if compared with traditional dedicated systems:

- Reliable and well proven solution - the concept is based on the world leading automation software (Wonderware).
- Easy to implement - you can use your Wonderware skills and application libraries to develop the main application.
- Wide application scope, easy integration – you can integrate pipeline/flow management and leakage detection to Wonderware visualization, reporting and MES concepts. The system is scalable from single workstation applications to wide distributed systems, and it interfaces with all major automation field buses and controllers.
- Low investment cost – you need just one add-on module to the standard Wonderware platform.
- Easy maintenance and upgrades – you can keep the main part of the system under Wonderware standard customer care contracts.

InBalance installation and starting-up

Setting-up from "Objects" installation package

The InBalance installation is available as **"Objects" installation package** (packed archive), containing Wonderware Application Server objects, two simple example models and some simulated Historian data. The appropriate exact Wonderware software is needed to be installed before the InBalance installation.

Software requirements

The following software is needed to be installed before the InBalance installation:

- Wonderware Application Server 3.1 SP1 or newer
- Wonderware InTouch 10.1 or newer
- Wonderware Historian (InSQL) 9.0 or newer
- Wonderware ActiveFactory 9.2
- MS Office 2003 or newer

Important Note!
InBalance has same hardware requirements as Wonderware Application Server: it is ***strongly recommended*** *to have: "Computer with 2 gigahertz (GHz) or faster processor, 32/64-bit. A multi-core processor is strongly recommended. The Intel Itanium 2 processor is not supported.".*

Contents of installation package

The InBalance installation package is delivered as a packed archive (e.g. InBalance_0618beta.zip) and contains the following files:

- **InBalanceObjects.aaPKG** – contains InBalance objects;

- **sample_manual.xml** – demo model using manually entered data;

- **sample_histdbase.xml** – demo model using simulated data from Historian database;

- **InBalanceReport.xls** – simple mass balance demo report;

- **InSQL.zip** – contains simulated Historian data for sample_histdbase.xml model.

Note!
In case demo models and demo reports are not planned to be used, only the installation of InBalanceObjects.aaPKG is required.

Beta version expiration

This InBalance beta version expires on 16th of April 2010 – starting from this date after Calculation Object deployment no more calculations will be possible (switching Calc.Trigger attribute from False to True will not work) and the following message will be logged to LogViewer:

"InBalance: Runtime Beta version has expired. Calculation request rejected."

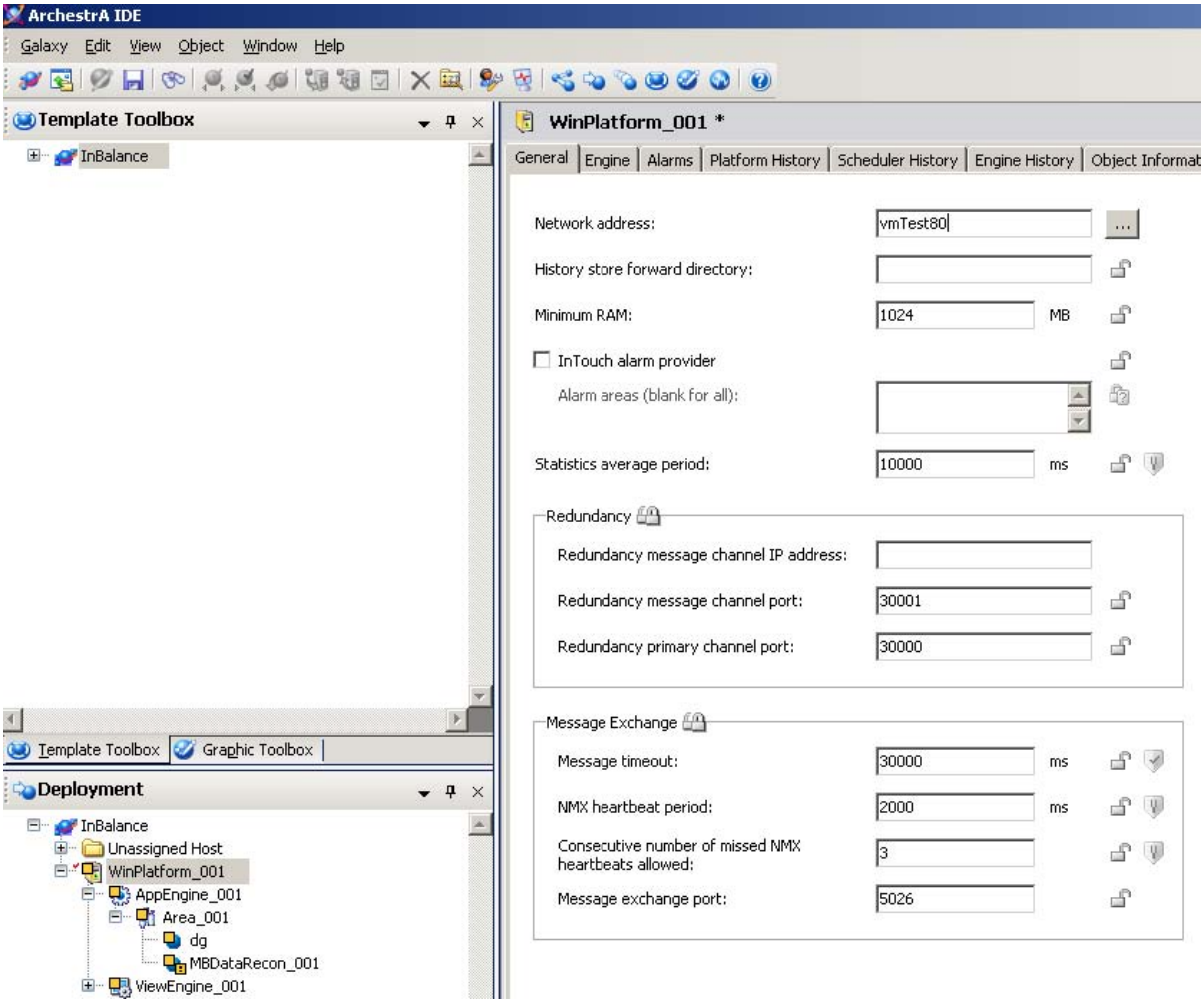
At same time any size of model can be drawn by Model Editor and deployed in Archestra IDE still after beta version expiration.

Installation of InBalance objects

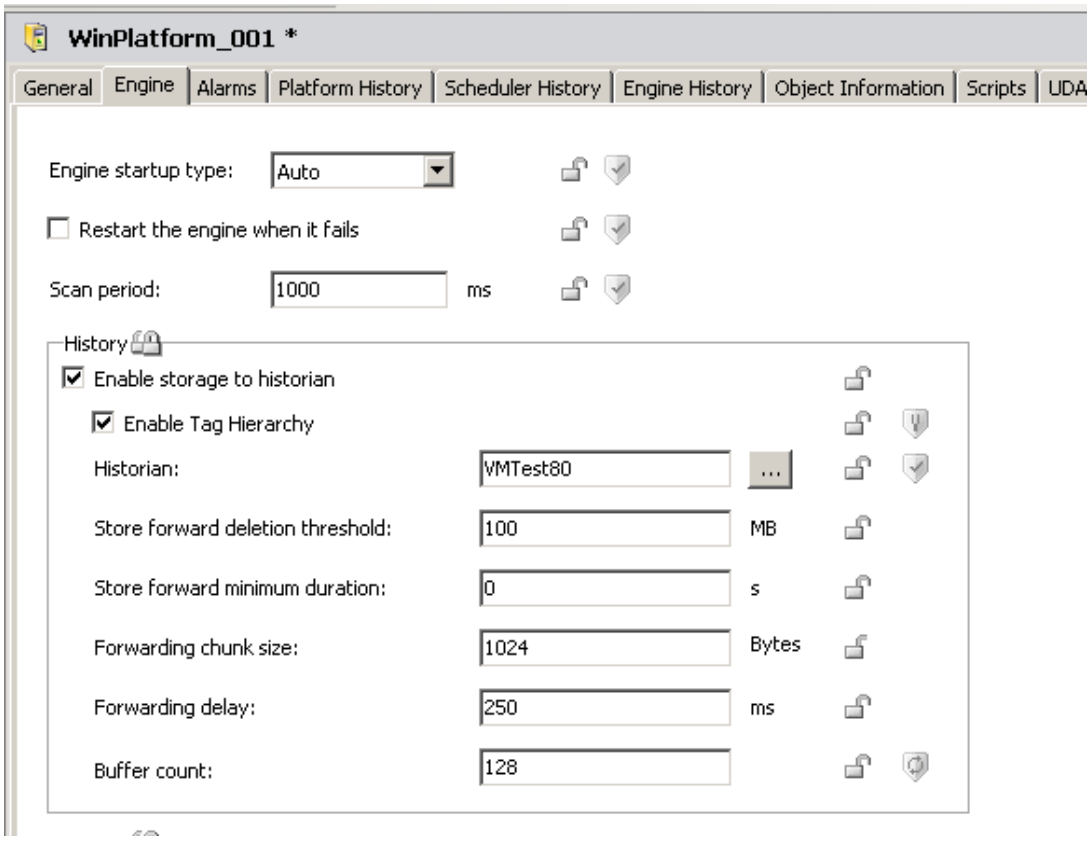
1) Create a new galaxy or use existing galaxy (in following explanation we will use newly created galaxy with name InBalance). Unpack the InBalance installation package to some location on your computer, e.g. to C:/InBalance.

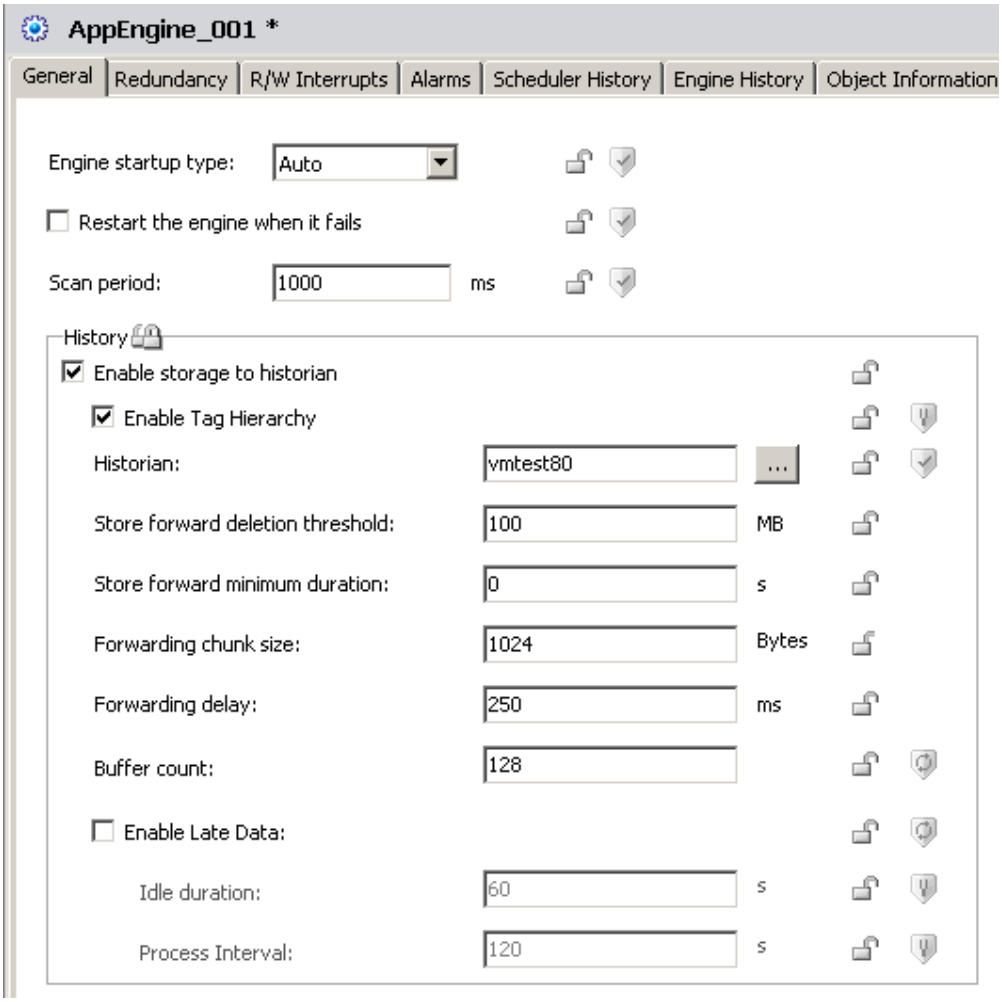
2) Import the InBalance objects file InBalanceObjects.aaPKG into the galaxy.

3) Configure WinPlatform_001 object – set network address to your PC hostname or IP Address:

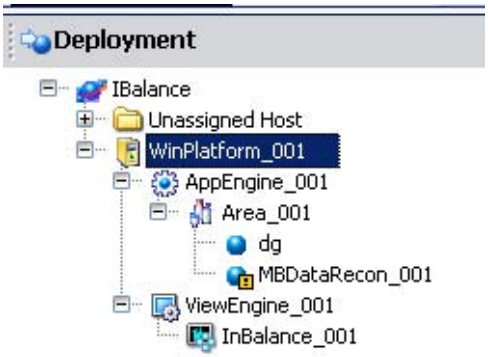

ArchestrA IDE
Galaxy Edit View Object Window Help
Template Toolbox
InBalance
Template Toolbox
Graphic Toolbox
Deployment
InBalance
Unassigned Host
WinPlatform_001
AppEngine_001
Area_001
dg
MBDataRecon_001
ViewEngine_001
WinPlatform_001 *
General
Engine
Alarms
Platform History
Scheduler History
Engine History
Object Informat
Network address:
vmTest80
History store forward directory:
Minimum RAM:
1024
MB
InTouch alarm provider
Alarm areas (blank for all):
Statistics average period:
10000
ms
Redundancy
Redundancy message channel IP address:
Redundancy message channel port:
30001
Redundancy primary channel port:
30000
Message Exchange
Message timeout:
30000
ms
NMX heartbeat period:
2000
ms
Consecutive number of missed NMX heartbeats allowed:
3
Message exchange port:
5026

4) Configure Historian for WinPlatform_001 and Appengine_001:





5) Deploy all InBalance objects – select WinPlatform_001 and deploy all platform:



Historian Server setup

In purpose to work with **sample_histdbase.xml** (demo model using simulated data from Historian database), following steps are required to set up the Historian (InSQL) Server:

1) Backup your current InSQL data (the contents of C:/InSQL/Data/Circular folder) in case there is any important data stored.

2) Delete the current contents of C:/InSQL/Data/Circular folder.

3) Extract InBalance simulated InSQL data from InSQL.zip archive (included in InBalance installation package) to your InSQL data folder (default location C:/InSQL/Data/Circular).

4) Start InSQL server in case not yet started.

Demo report file location

In purpose to work with **InBalanceReport.xls** (simple mass balance demo report), to enable the automatic opening of demo report by pressing “Report” in InTouch application, the InBalanceReport.xls file should be copied to following location:

C:\Documents and Settings**[logged user name]**\Application Data\Microsoft\Excel\XLSTART\

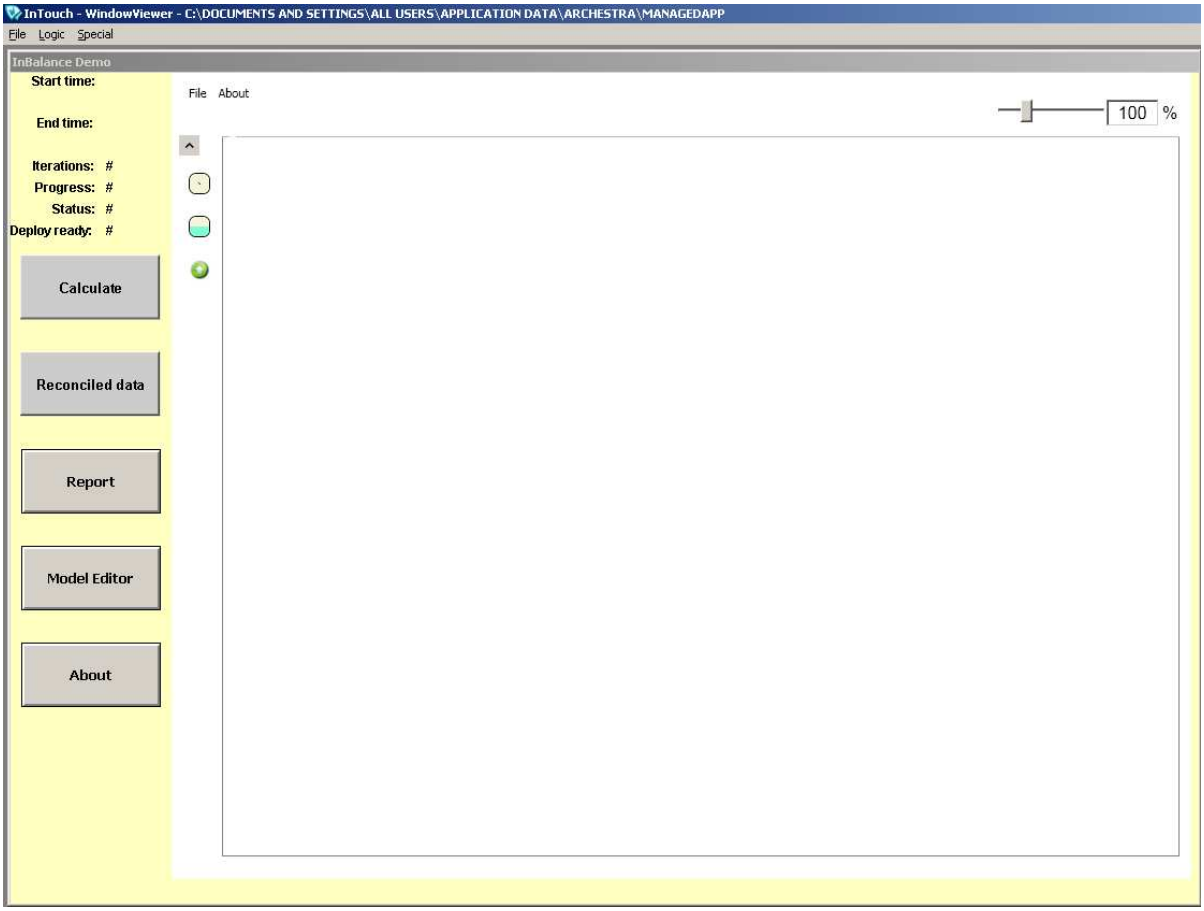
For example, to:
C:\Documents and Settings**gr**\Application Data\Microsoft\Excel\XLSTART\

Getting started by using “sample_manual.xls” model

After InBalance objects are installed and deployed, the InTouch Managed application (Instance – InBalance_001) and demo model using manually entered data (sample_manual.xml) can be used to become familiar with basics how to use InBalance solution.

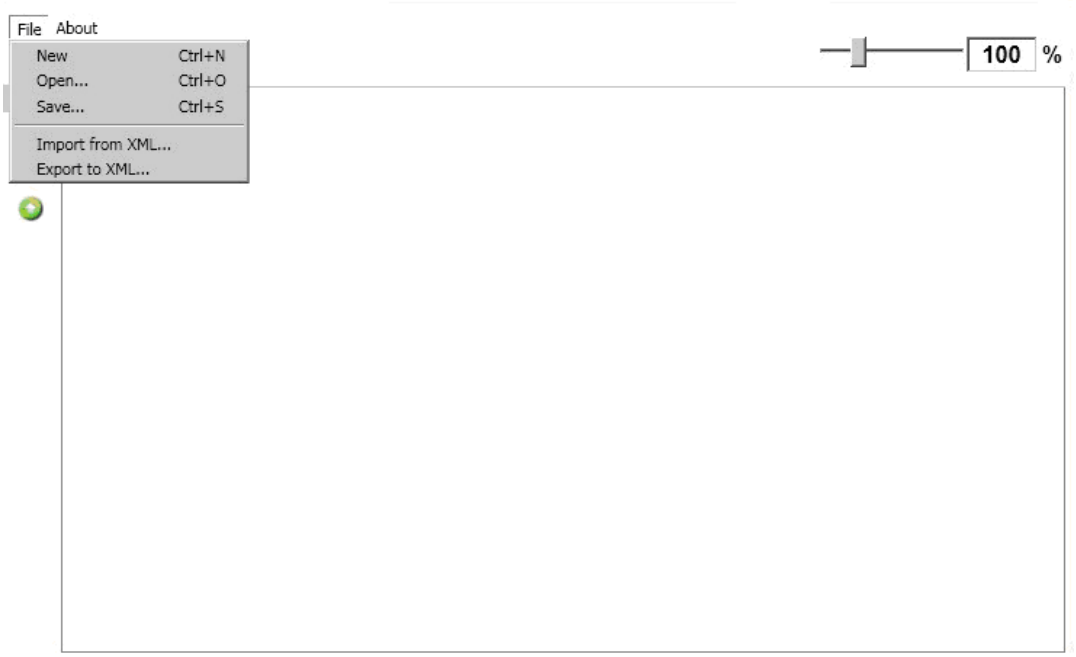
The following steps are required:

1) Run InTouch Managed application, instance – InBalance_001 (in case cannot be started directly by running WindowViewer then start it from InTouch Application Manager, where it’s name is $InBalance):

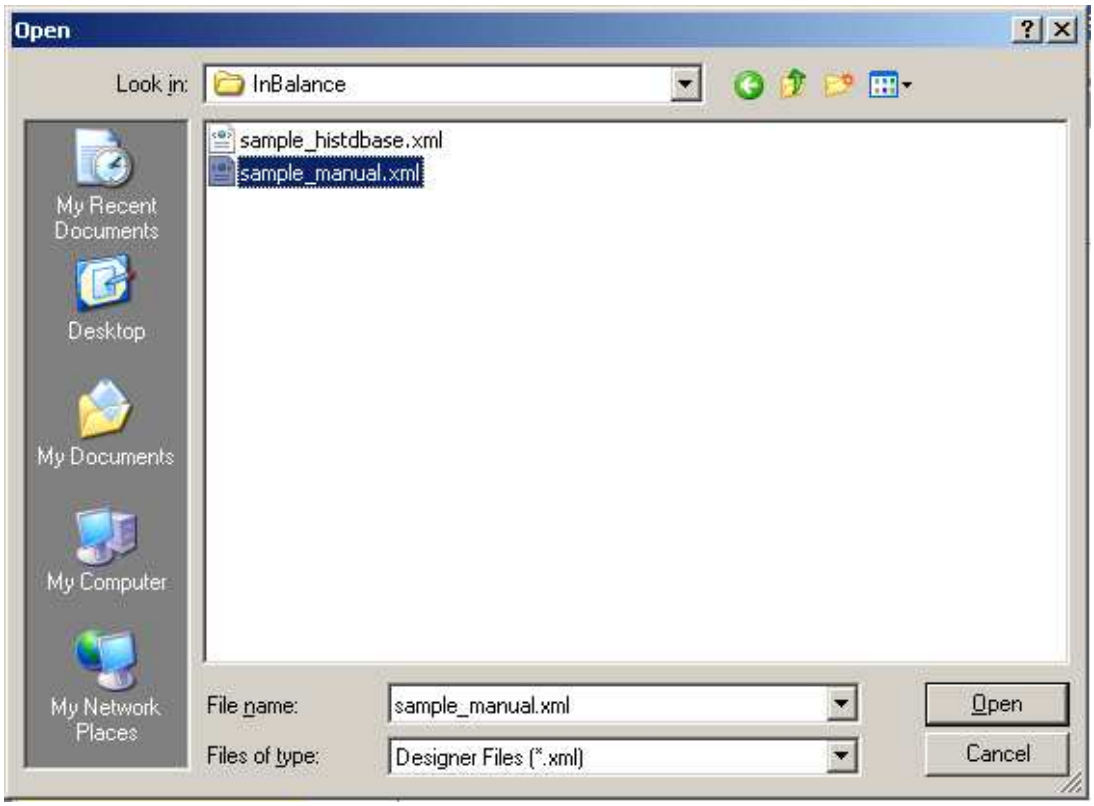


Note – to be able to start InTouch Managed application, computer needs to be connected to network.

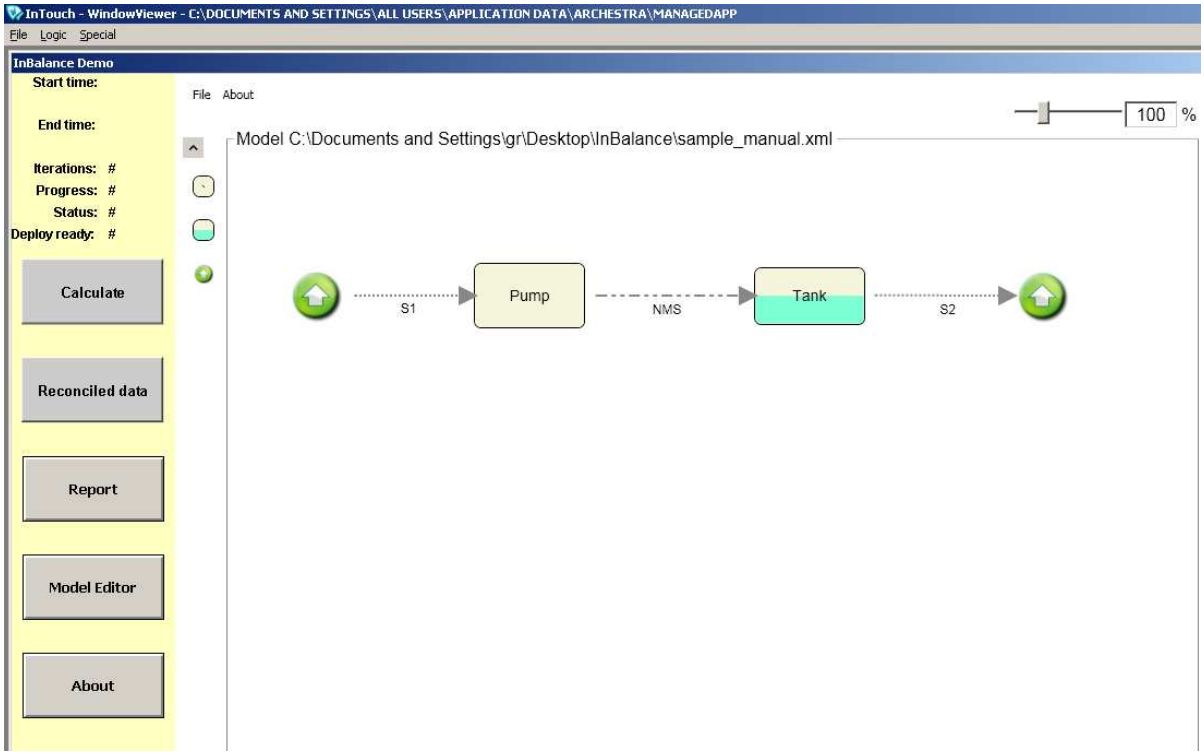
2) Import new model in Model Editor (from Model Editor main menu -> File ->Import from XML..):



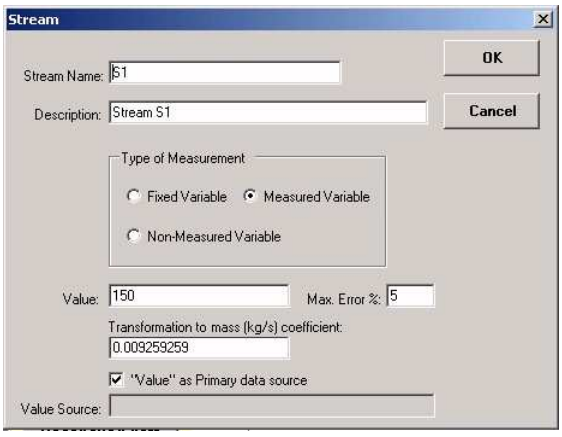
3) Browse for sample_manual.xml – demo model using manually entered data:

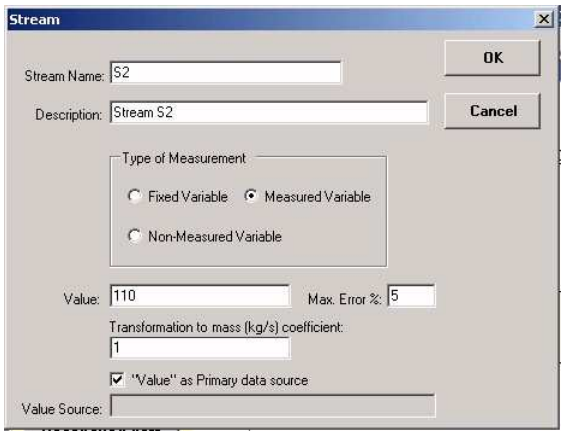


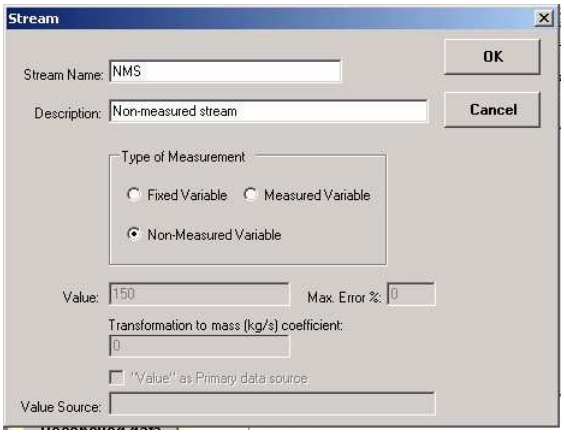
4) Click “Open”. The sample_manual.xml demo model will appear on Model Editor window:

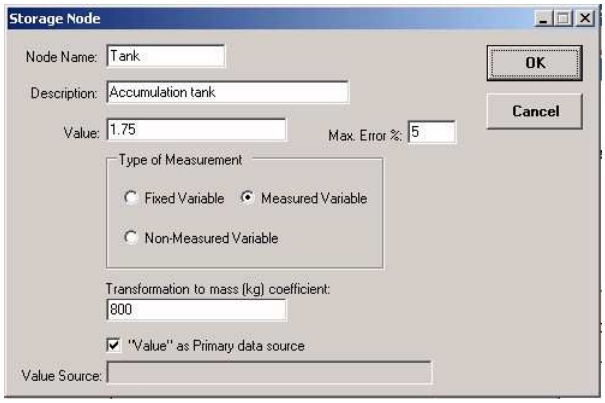


5) Examine the contents of streams S1, NMS, S2 and storage node Tank by double-clicking on them:





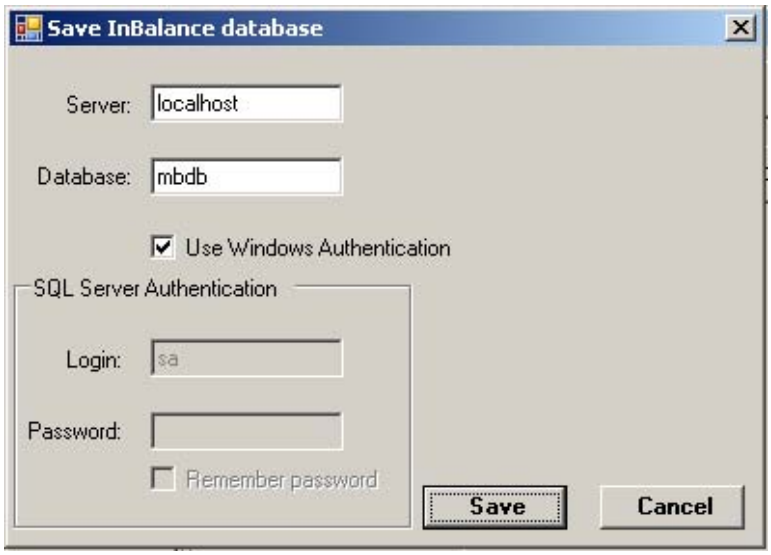




You can see streams **S1** and **S2** are measured streams, **NMS** is non-measured stream and **Tank** is a storage node with measured accumulation. For S1, S2 and Tank the values are entered **manually** in “Value” field, what means: for streams it is constant flow rate during time interval used in calculation and for storage node it is accumulation difference during the time interval used in calculation (e.g. end volume - start volume).

In this demo model all measured data (data in “Value” field) is in **m3/day** (for streams) and in **m3** (for storage node), so transformation to **kg/s** (for streams) and to **kg** (for storage node) is required for calculation:

The transformation to mass coefficient is implemented the following way:
- for stream **S1** it is entered directly in “Stream” configuration dialog equal to 0.009259259, according to following formula: = density /24 /3600 (where density is 800kg/m3);
- for stream **S2** the default coefficient 1 is used and transformation to mass coefficient is calculated in object script according to same formula as above for stream S1 (see *Transformation to mass (kg/s or kg) coefficient* section later in this manual);
- for non-measured stream **NMS** the transformation to mass coefficient is calculated in object script same way as for stream S2;
- for storage node **Tank** it is entered directly in “Storage Node” configuration dialog an it is equal to 800 – assuming density is 800kg/m3.
6) Create/save model configuration to internal MS SQL database (from Model Editor main menu -> File -> Save...):



Here the following information related with internal MS SQL database used by InBalance can be entered:

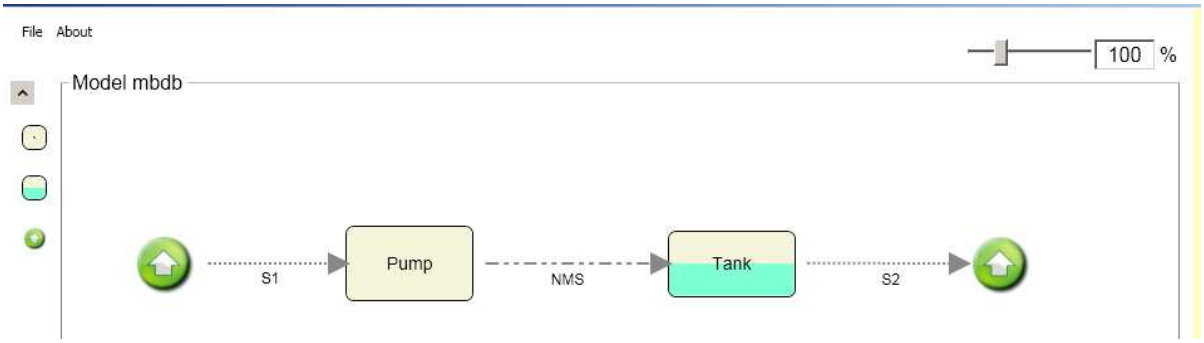
Server
Computer node name where internal MS SQL database is located.

Database
Internal MS SQL database name used by InBalance.

Login and Password
In case SQL Server authentication (not Windows authentication) is used the here the user name for accessing internal MS SQL database and password for accessing internal MS SQL database can be entered.

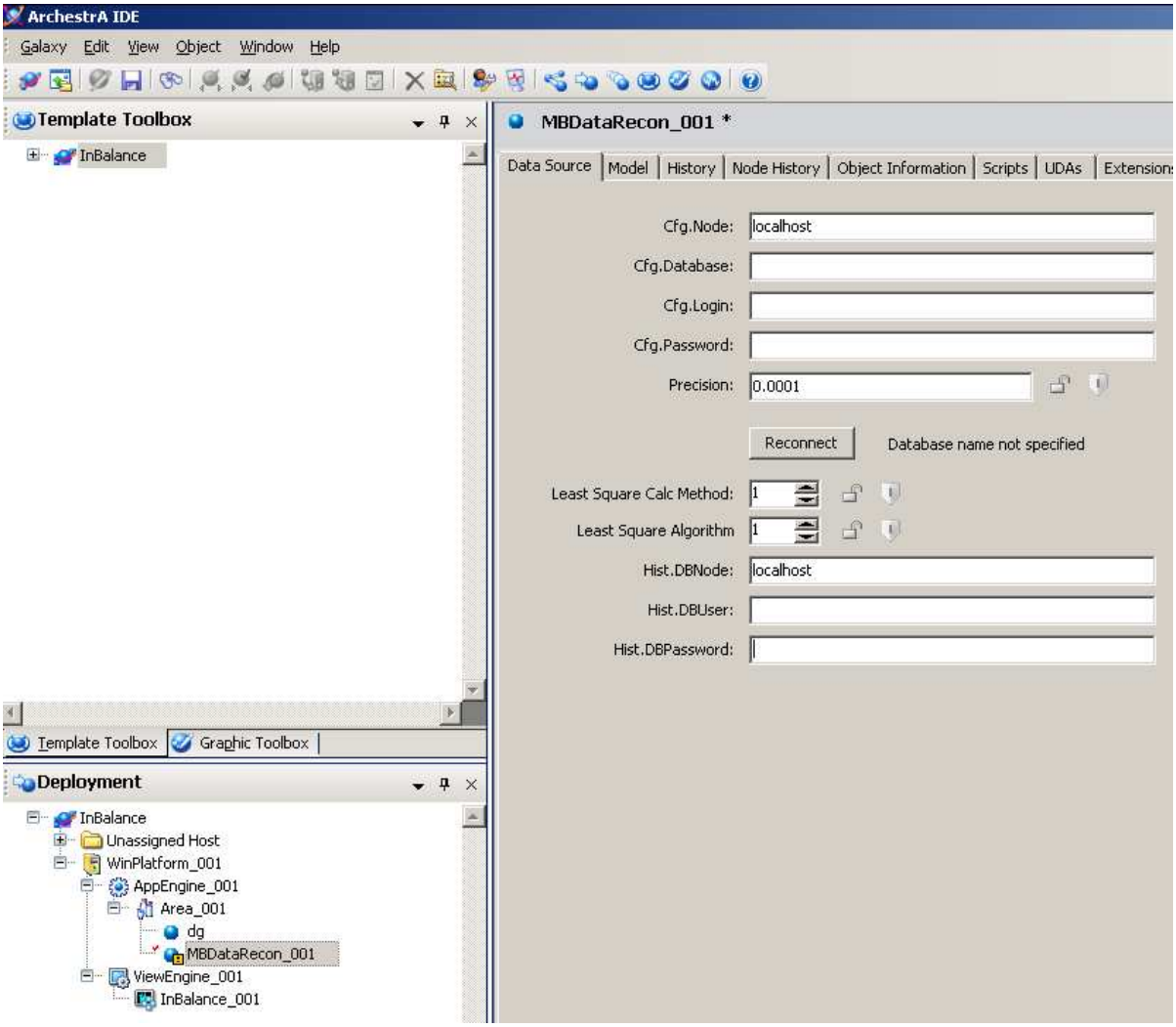
Note:
To create model database, you need to logon to MS SQL with user that have rights to create a database, since a new MS SQL database will be created that is used to store the model.

After clicking “Save”, the current database name entered (“mbdb” in our case) will be displayed on Model Editor window:

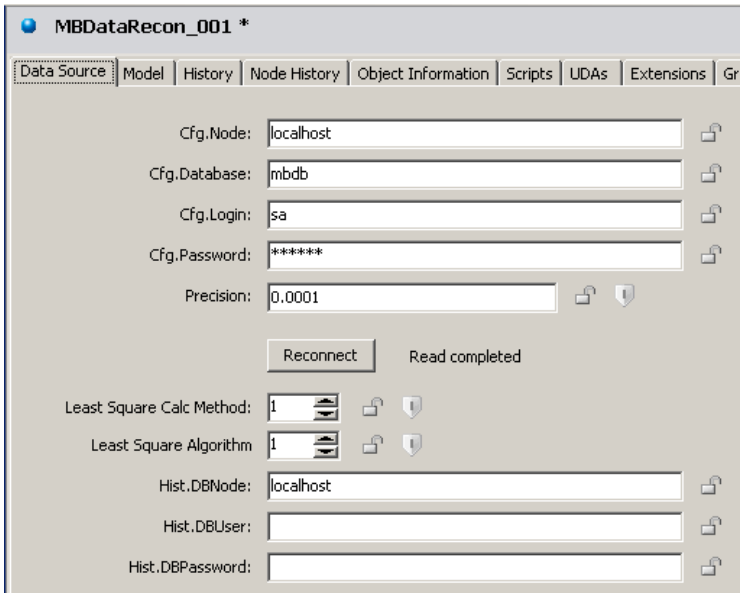


7) Start Archestra IDE (in case not yet started).

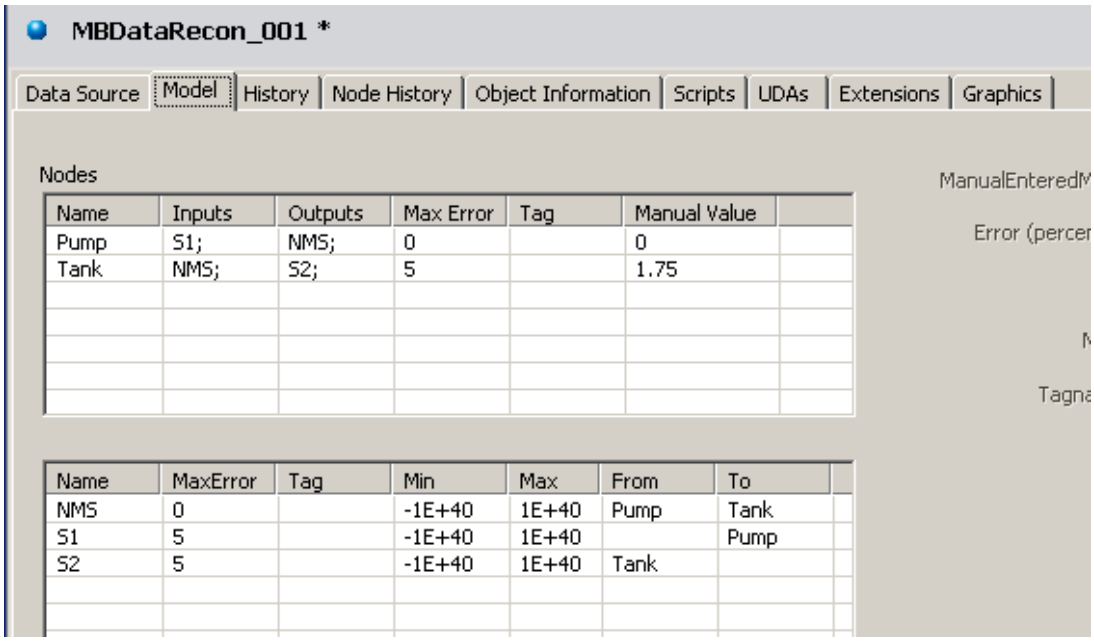
8) Open “MBDataRecon” object configuration editor:



7) In “Cfg.Node” field enter the computer name where InBalance internal MS SQL database is located, in “Cfg.Database” field enter the model database name (“mbdb” in our case), in “Cfg.Login” and “Cfg.Password” fields enter the MS SQL Server username and password and press “Reconnect” button to read the model configuration from internal MS SQL database:



7) Check if model is loaded correctly – select the Object Editor “Model” tab:



If there are no any nodes and streams loaded then check “Data source” tab configuration and Wonderware (SMC) logger for possible reason.

8) In purpose to be able to invoke the MS Excel with simple mass balance report, it is necessary to enable appropriate “History extensions” at “History” and “Extensions” tabs (for more information refer to *Historization of calculation results* section later in this manual).

For the following atributes check the “Historized” checkbox at “History” tab:

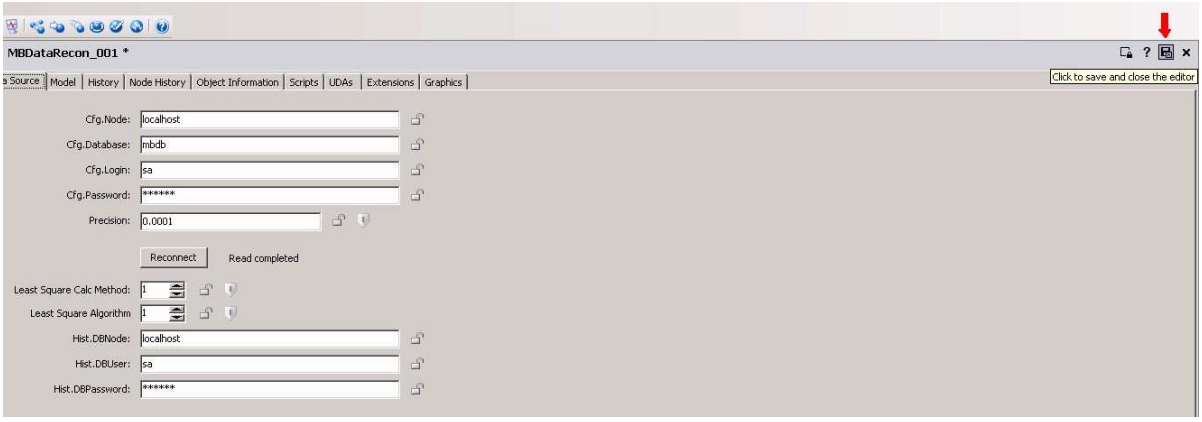
Calc.TotalMeasInput

Calc.TotalMeasOutput
Calc.TotalMeasAccum
Calc.TotalRecInput
Calc.TotalRecOutput
Calc.TotalRecAccum

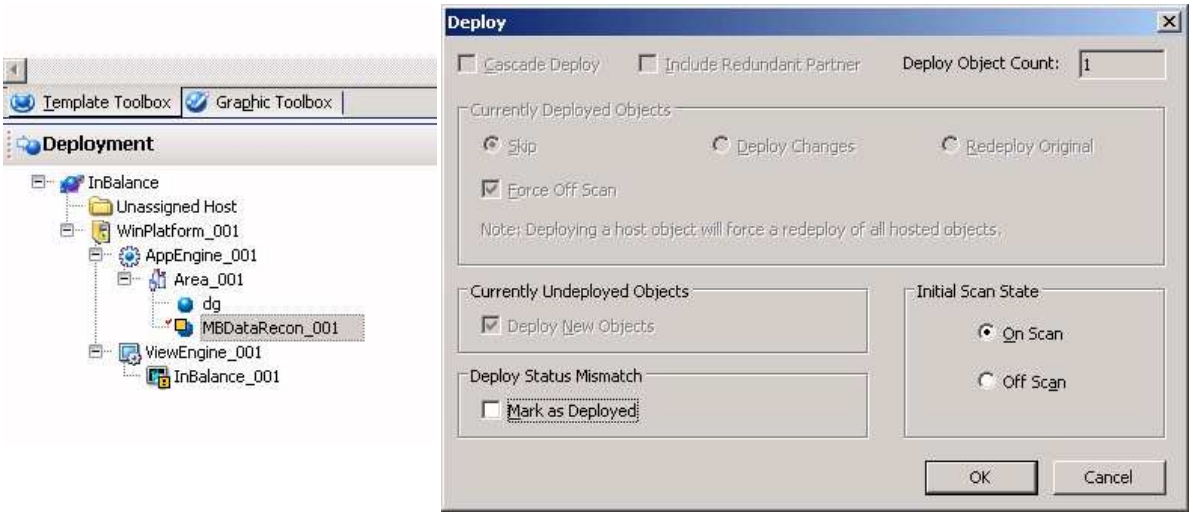
For the following attributes enable the “History extension” at “Extensions” tab:

NMS.Meas.MeasuredMass
NMS.Meas.ReconMass
NMS.Meas.TransfCoef
Pump.TotalMeasInput
Pump.TotalMeasOutput
Pump.TotalRecInput
Pump.TotalRecOutput
S1.Meas.MeasuredMass
S1.Meas.ReconMass
S1.Meas.TransfCoef
S2.Meas.MeasuredMass
S2.Meas.ReconMass
S2.Meas.TransfCoef
sEndTime
sStartTime
Tank.TotalRecInput
Tank.TotalRecOutput
Tank.TotalRecInput
Tank.TotalRecOutput
Tank.Meas.MeasuredMass
Tank.Meas.ReconMass
Tank.Meas.TransfCoef

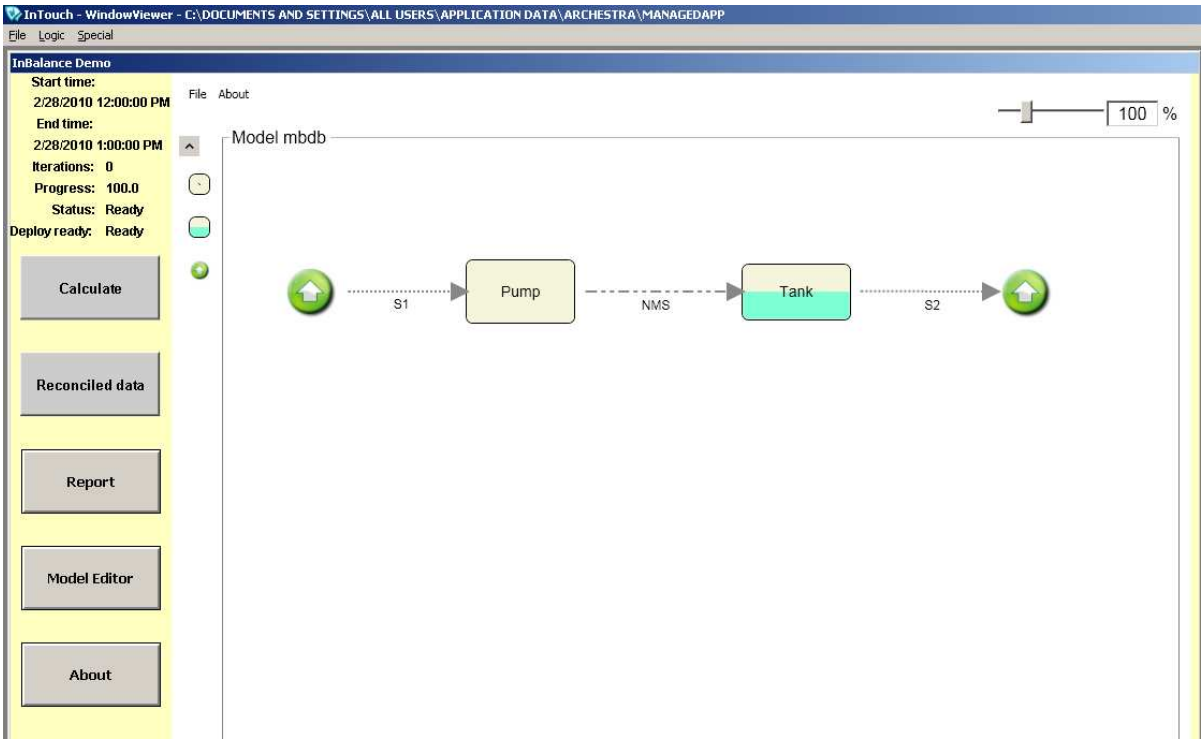
9) Save and close the current “MBDataRecon_001 object configuration by clicking on Close/Save icon located at right upper corner of Object Editor:



10) Deploy MBDataRecon_001 object:



11) Return to InTouch. The sample_manual.xml demo model now is loaded and ready for use. The data reconciliation, mass balance calculation, visualization and reporting of results now can be done from InTouch “InBalance Demo” window:



There are following elements on InTouch “InBalance Demo” window:

- **“Start time”** and **“End time”** are used to enter the calculation time interval; currently here are deafult settings “Start time” 2/28/2010 12:00 PM and “End time” 2/28/2010 13:00 PM – one hour calculation interval;

- **“Solvable”** shows if model is solvable – if Me.Calc.Solvable attribute after calculation is True – model is solvable, if False - model is not solvable;

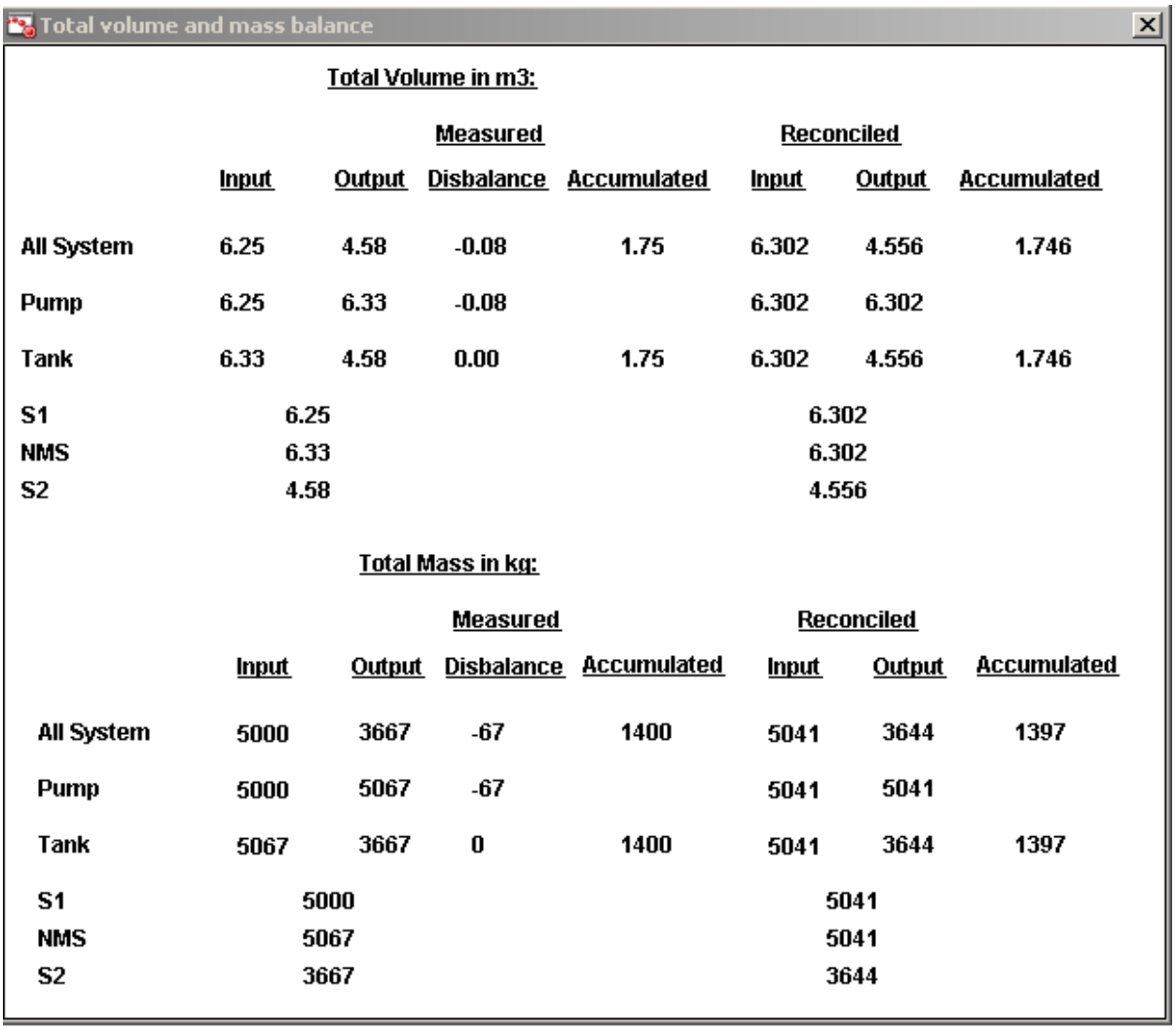
- **"Iterations"** – shows the count of mathematical iterations used to perform the calculation;

- "**Process**" – displays the calculation progress in % from 0 to 100;

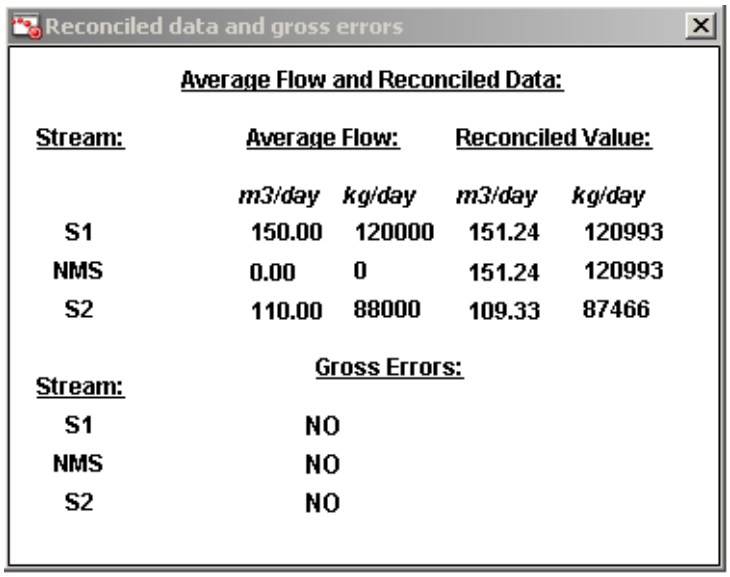
- **"Status"** indicates the state of calculation: "Ready" or "Not ready"; the "Ready" state indicates next/new calculation can be done by pressing "Calculate all time period" or "Calculate last 2 hours " buttons;

- **"Deploy ready"** indicates the system state of "MBDataRecon" object deployment: "Ready" or "Not ready"; the "Ready" state indicates next/new calculation can be done by pressing "Calculate all time period" or "Calculate last 2 hours " buttons;

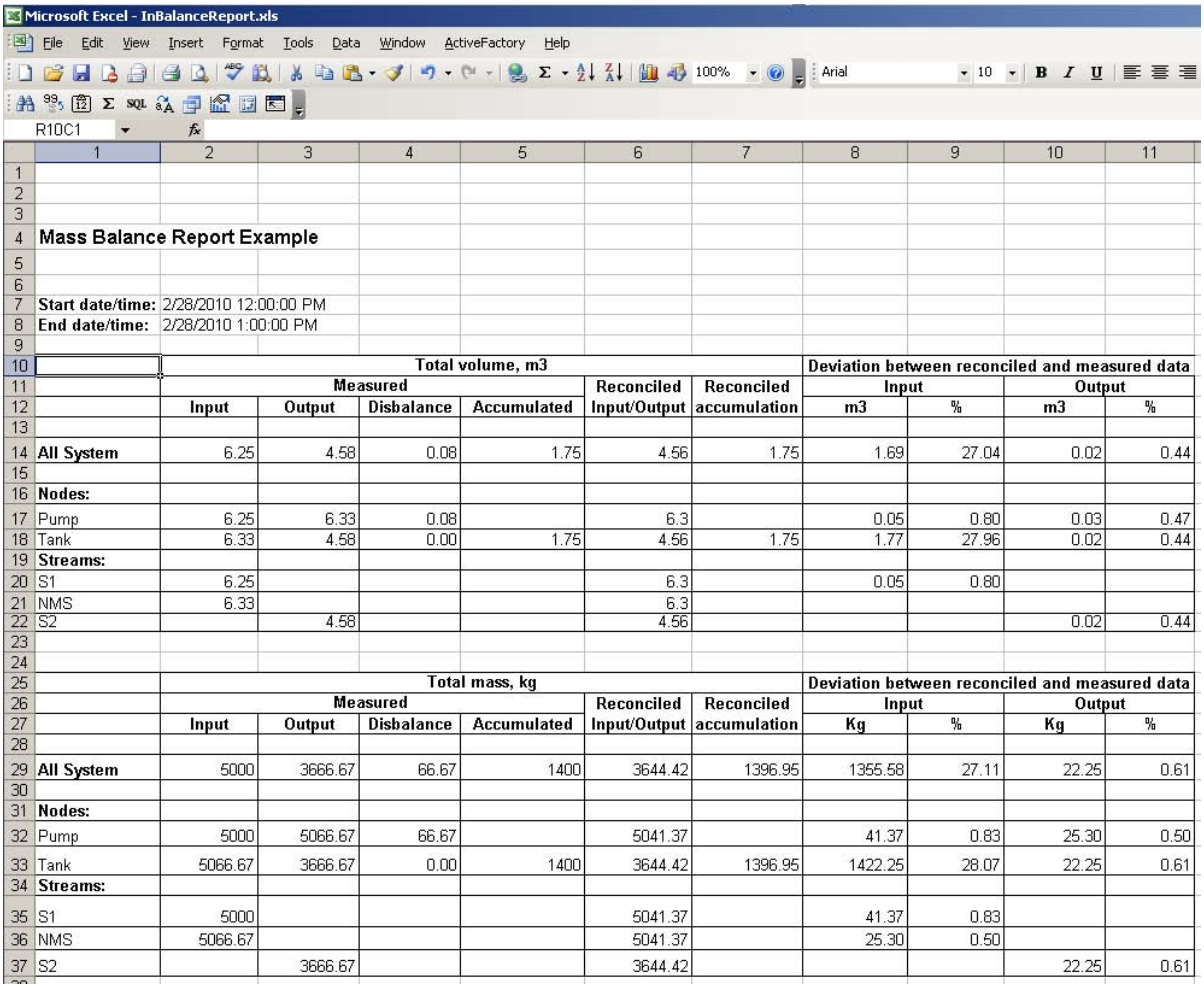
- **"Calculate"** button is used to perform the calculation for time interval specified in "Start time" and "End time" field; by pressing this button the "Total volume and mass balance" window will open, where total volumes in m3 and mass balances in kg are displayed:



- **"Reconciled data"** button is used to open window with last calculation reconciled data for all streams (in m3/day and kg/day) and gross errors (if any) displayed:



- "Report" button can be used to invoke the MS Excel with simple mass balance report generated based on last calculation:



Microsoft Excel - InBalanceReport.xls

File Edit View Insert Format Tools Data Window ActiveFactory Help

R1C1

Mass Balance Report Example

Start date/time: 2/28/2010 12:00:00 PM
End date/time: 2/28/2010 1:00:00 PM

	Total volume, m3						Deviation between reconciled and measured data			
	Measured				Reconciled	Reconciled	Input		Output	
	Input	Output	Disbalance	Accumulated	Input/Output	accumulation	m3	%	m3	%
All System	6.25	4.58	0.08	1.75	4.56	1.75	1.69	27.04	0.02	0.44
Nodes:										
Pump	6.25	6.33	0.08		6.3		0.05	0.80	0.03	0.47
Tank	6.33	4.58	0.00	1.75	4.56	1.75	1.77	27.96	0.02	0.44
Streams:										
S1	6.25				6.3		0.05	0.80		
NMS	6.33				6.3					
S2		4.58			4.56				0.02	0.44

	Total mass, kg						Deviation between reconciled and measured data			
	Measured				Reconciled	Reconciled	Input		Output	
	Input	Output	Disbalance	Accumulated	Input/Output	accumulation	Kg	%	Kg	%
All System	5000	3666.67	66.67	1400	3644.42	1396.95	1355.58	27.11	22.25	0.61
Nodes:										
Pump	5000	5066.67	66.67		5041.37		41.37	0.83	25.30	0.50
Tank	5066.67	3666.67	0.00	1400	3644.42	1396.95	1422.25	28.07	22.25	0.61
Streams:										
S1	5000				5041.37		41.37	0.83		
NMS	5066.67				5041.37		25.30	0.50		
S2		3666.67			3644.42				22.25	0.61

- **"Model Editor"** button can be used to invoke the separate "Model Editor" window;

- **"About"** button can be used to invoke the InBalance general description window.

12) Now, by changing the "Start time" and "End time", the calculation can be performed for different time intervals (using same default manually entered values).

To peform the calculation for same model with modified parameters – see *Changing the parameters within same model* section later in this manual.

To peform the calculation for different model – see *Changing the model* section later in this manual.

Changing the model and parameters

Working with Model Editor

The Model Editor is a .NET Control, which can be used in Wonderware InTouch or other .NET Container. The Model Editor allows to draw and create a model consisting of nodes and streams and configure their parameters.

There are three Model Editor node elements available (located on toolset at upper left corner of Model Editor window);

- ”normal” node;
- ”storage” node;
- ”environment” node (external source or destination from/to material is coming to or moving out from system; e.g. oil well or consumer facility).

The following basic actions can be done:

Adding “environment” node

Select the “environment” node from toolset and drag-drop it to necessary location on the model:

Adding and configuring “normal” node

Select the “normal” node from toolset and drag-drop it to necessary location on the model - the ”Add New Node” configuration dialog will open:

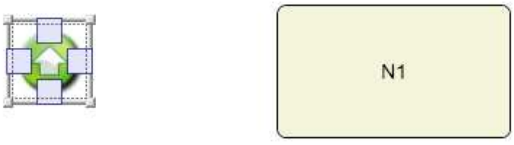
Enter the **Node Name** and **Description** (optional) and click OK - new node is added to the model:

If you like you can move the node to other location by using mouse or keyboard direction keys; it is also possible to resize the node object by using mouse. Already created node can be edited bu double clicking on it and entering new parameters in ”Node” configuration dialog:

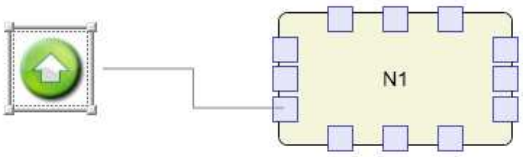
Adding and configuring stream

Stream is connecting two already created nodes. To create a new stream:

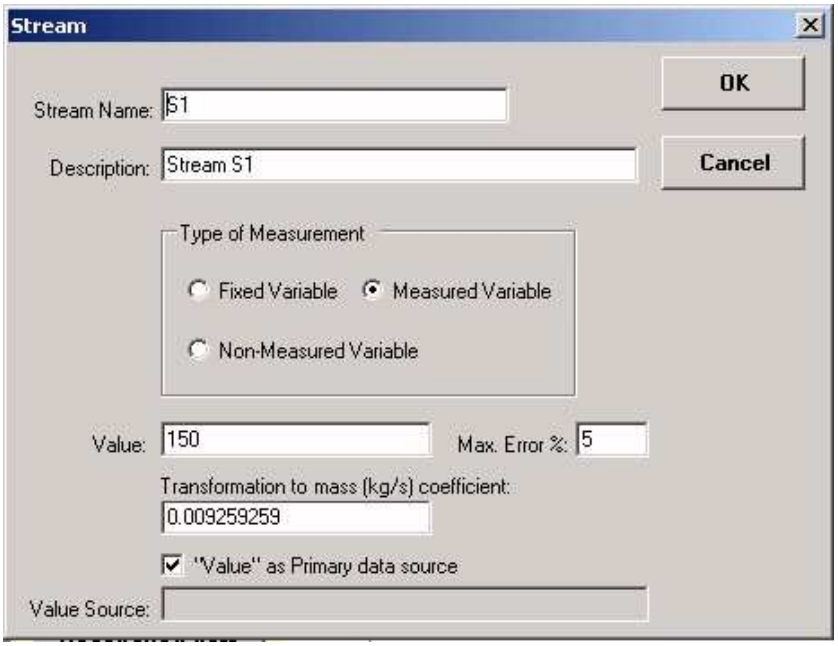
- Select source node (“environment” node in picture below) and connection points (connectors) will appear (“environment” node has 4 connectors); locate mouse over one of connectors and press mouse left button:



- By holding left mouse button, drag connection over the destination node:



- Select one of 12 connectors on destination node (“normal” and “storage” nodes has 12 connectors) and release mouse left button – the „Add New Stream” connection dialog will open:



- Enter the **Stream Name**, **Description** (optional) and other parameters:

Type of Measurement
The available selections are ”Fixed” (errorless), ”Non-Measured” and ”Measured”,

Value
For ”Fixed” and ”Measured” types the measurement value can be entered manually; for ”Measured” type the ”Value” will be used in calculation only in case the””Value” as Primary data source” is checked.

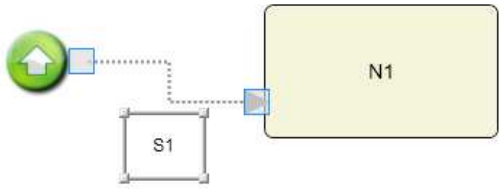
Max. Error %
The measurement precision in %.

Transformation to mass (kg) coefficient
This setting can be used in case the measured data is not in kg/s, allowing to calculate mass from stored in Historian measured data or from manually entered data. Default setting is 1 (stored in Historian measured data or manually entered value is already in kg/s). See *Transformation to mass (kg/s or kg) coefficient* section later in this manual for more information.

”Value” as Primary data source
If checked then manually entered ”Value” will be used in calculation. If not checked then calculation will use stored in Historian measured data.

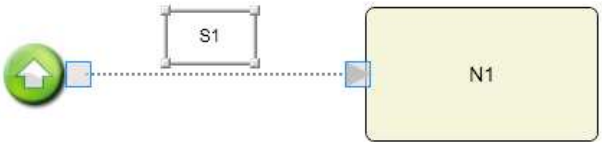
Value Source
The Historian tagname used to store the measured data for this stream.

- Afer clicking ”OK” button, new stream is created and added to the model:



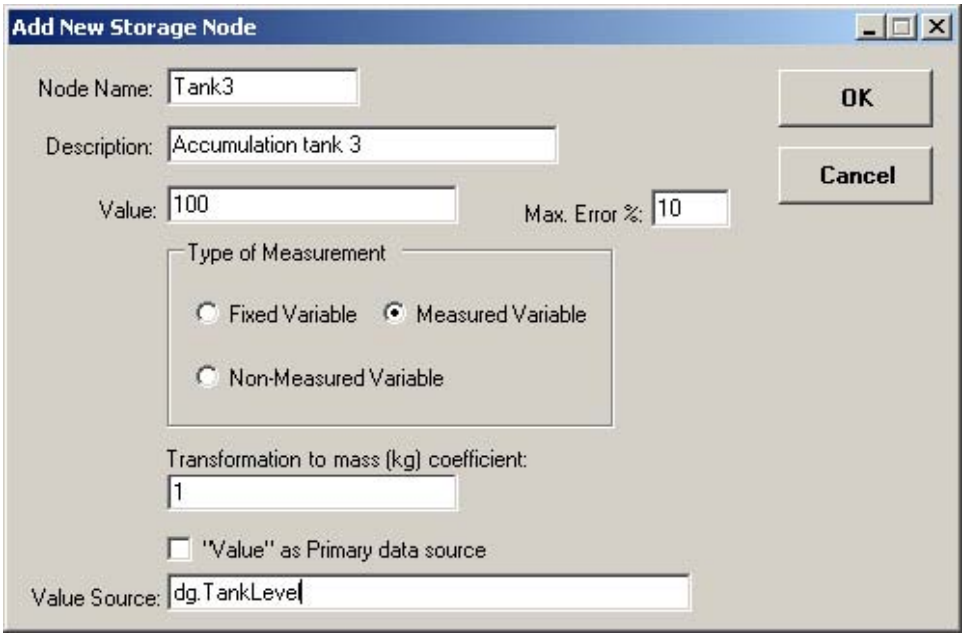
Adjusting connections and location of elements

The connection (end points of stream) can be adjusted/changed by clicking on stream name, selecting end point and dragging it to new location. The stream name location can be changed by clicking on it and dragging to any location. The resizing of nodes and stream names can be done by selecting the element and dragging any of element corner:



Adding and configuring “storage” node

Select the “normal” node from toolset and drag-drop it to necessary location on the model - the ”Add New Storage Node” configuration dialog will open:



- Enter the **Node Name**, **Description** (optional) and other parameters:

Type of Measurement

The available selections are ”Fixed” (errorless), ”Non-Measured” and ”Measured”,

Value

For ”Fixed” and ”Measured” types the accumulation value (storage difference for defined time period) can be entered manually; for ”Measured” type the ”Value” will be used in calculation only in case the””Value” as Primary data source” is checked.

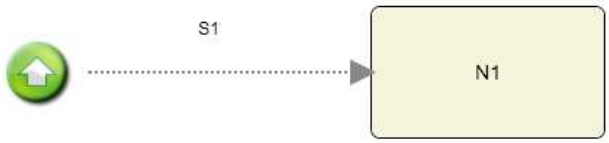
Max. Error %
The accumulation measurement precision in %.

Transformation to mass (kg) coefficient
This setting can be used in case the measured data is not in kg, allowing to calculate the accumulation from stored in Historian measured data or from manually entered value. Default setting is 1 (stored in Historian measured data or manually entered value is already in kg). See *Transformation to mass (kg/s or kg) coefficient* section later in this manual for more information.

”Value” as Primary data source
If checked then manually entered ”Value” will be used in calculation. If not checked then calculation will use stored in Historian measured data.

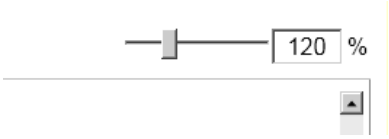
Value Source
The Historian tagname used to store the measured data for this storage node.

- Afer clicking ”OK” button, new ”storage” node is created and added to the model:



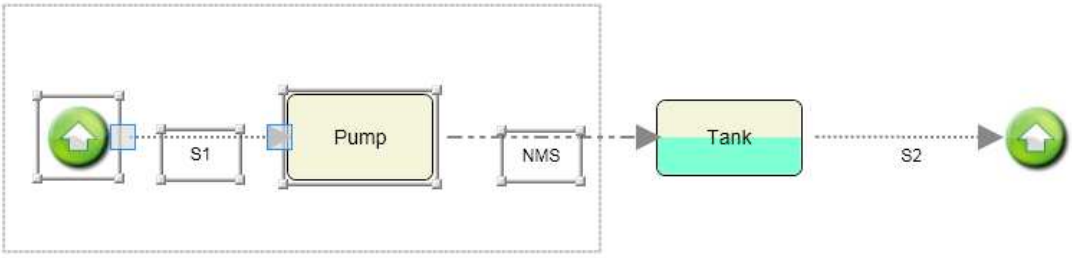
Zooming

Model Editor supports zooming from 10% to 1600% - you can select the different zooming by entering % manually or moving slider on the top-right of Model Editor:

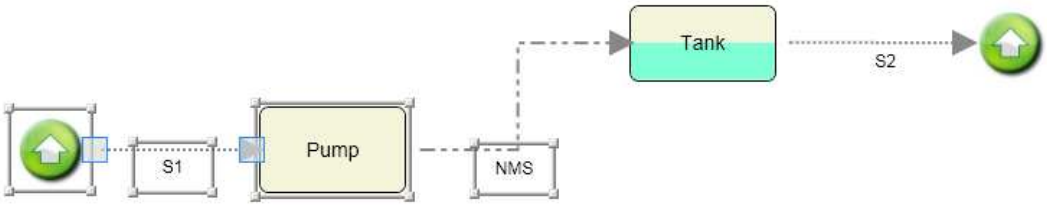


Moving selected area

Model Editor supports possibility to select area (and all elements inside this area) and drag-drop it to necessary new location. The area can be selected by locating mouse on selected area corner, clicking mouse left button, moving mouse without releasing left button to area other corner and releasing mouse left button:



All elements inside the selected area now can be moved to new location by using keyboard ”arrow” keys (”up”, ”down”, ”left” and ”right”):

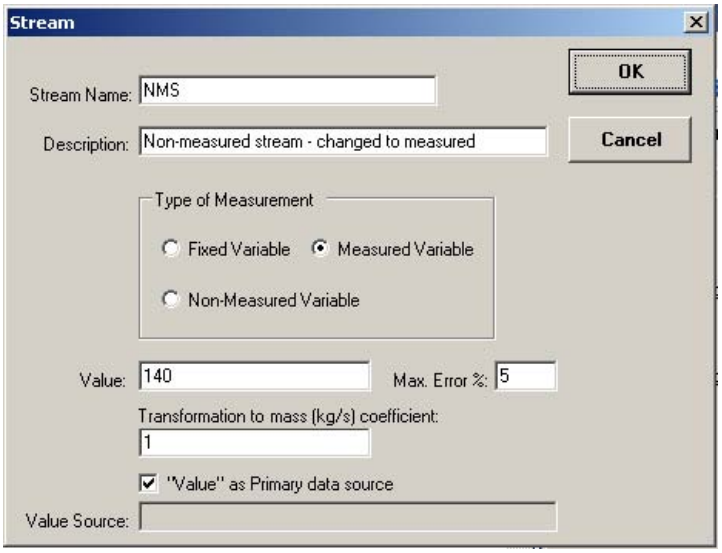


Changing the parameters within same model

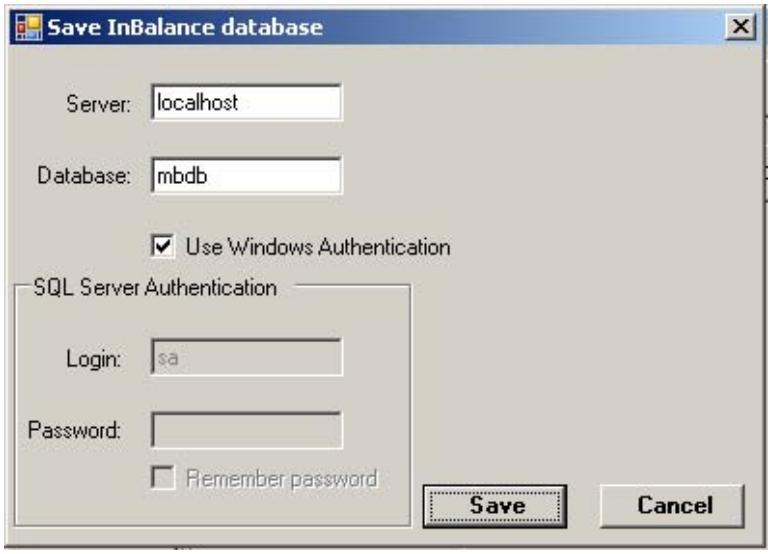
This section explains how to modify the parameters of streams or nodes within existing model and perform the calculation by using changed parameters (model remains unchanged – number of nodes and streams, their names and links between them remain the same).

For example, the following steps are required to change stream NMS from “non-measured” to “measured/manually entered value”:

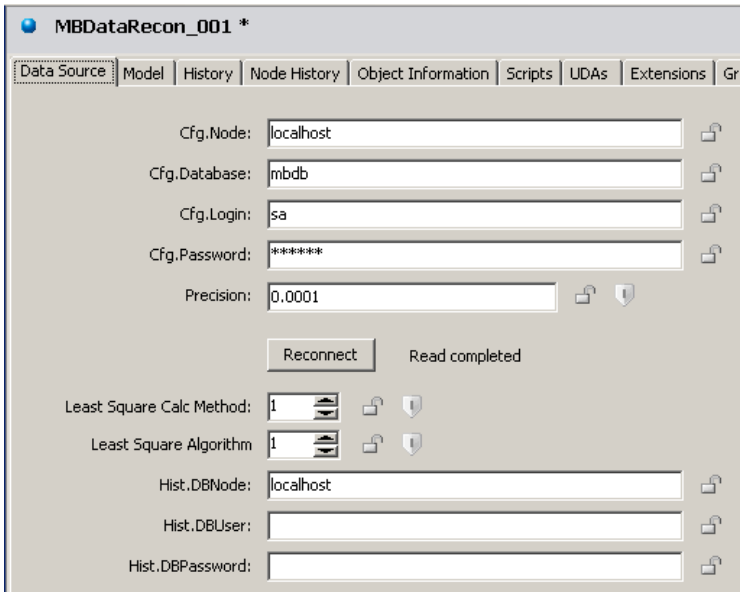
1) Go to Model Editor, double click on stream NMS to change its configuration – check “Measured variable” and ““Value” as Primary data source”, enter “Value”: 140 (in m3/day), leave “Transformation to mass (kg) coefficient” equal to 1 and “Max. Error %”: 5 and click “OK”:



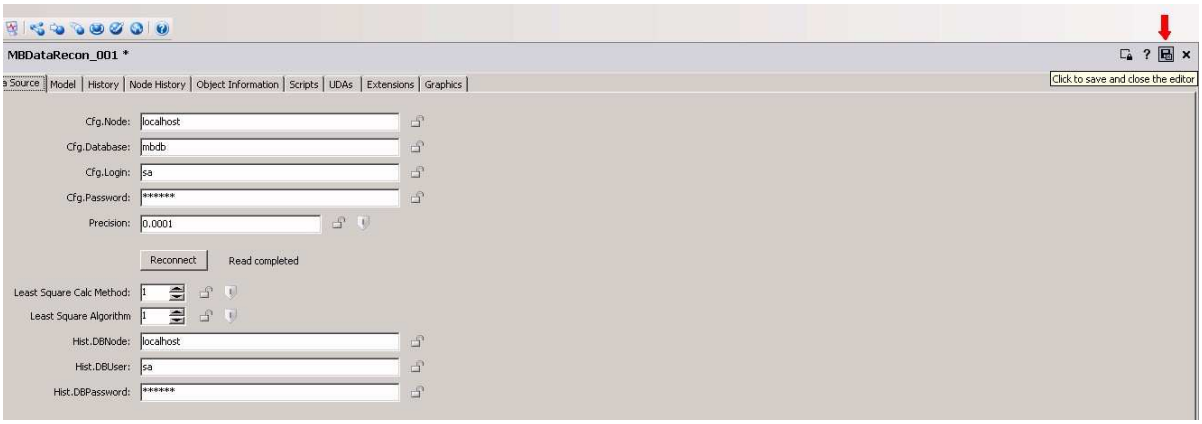
2) Save model configuration to internal MS SQL database (from Model Editor main menu -> File -> Save...):



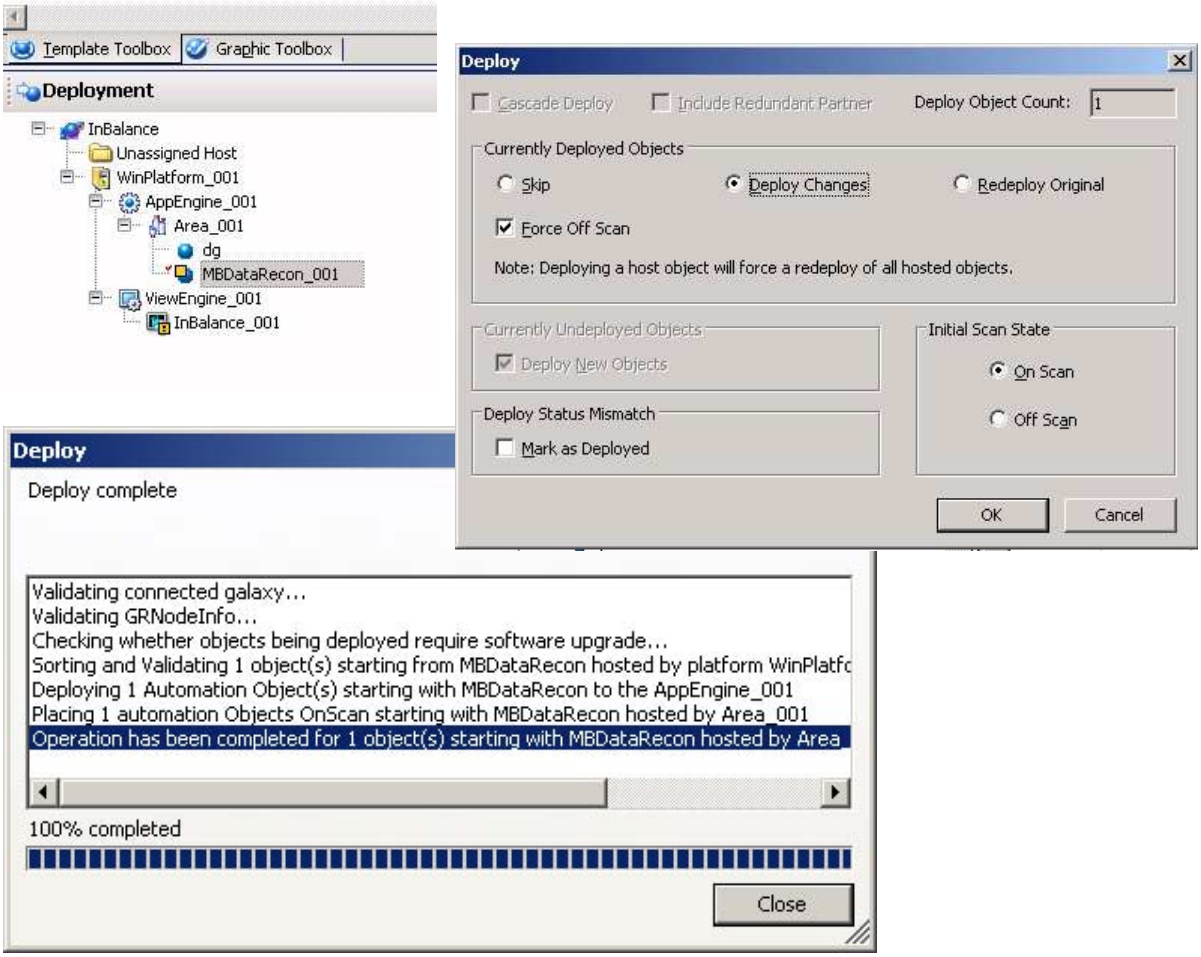
3) Open ArchestrA IDE (if not yet opened), browse to MBDataRecon_001 object and open its editor:



4) Save and close the current “MBDataRecon” object configuration by clicking on Close/Save icon located at right upper corner of Object Editor:



5) Deploy “MBDataRecon” object:



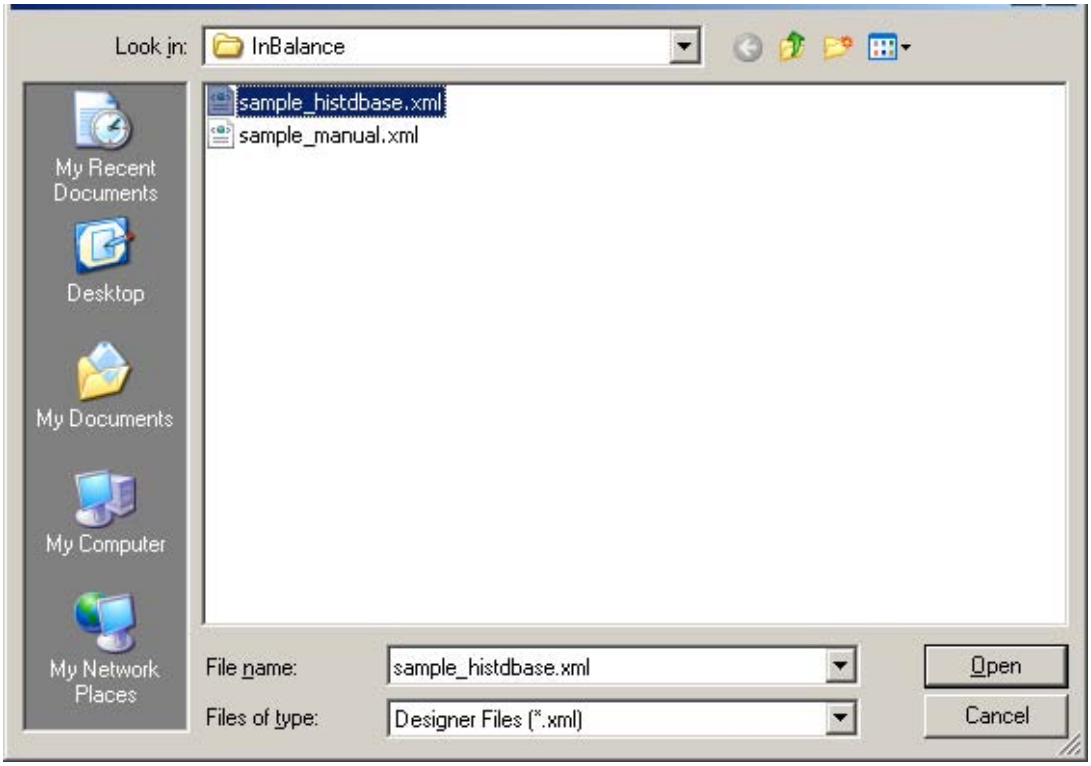
6) After deploy is finished, return to InTouch and wait until **“Deploy ready”** indicating the system state of “MBDataRecon” object deployment changes to “Ready.

7) Press ”Calculate” button to perform the calculation. Now, by changing the “Start time” and “End time”, the calculation can be performed for different time intervals (using the same model current configuration).

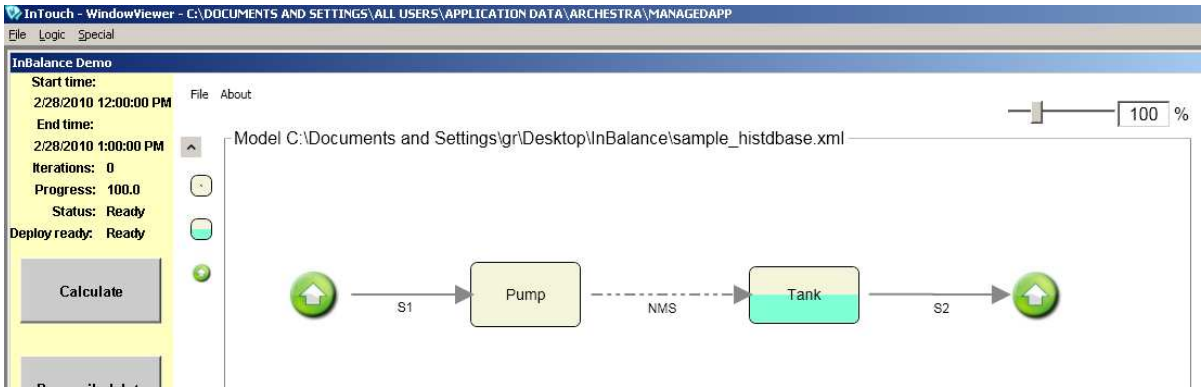
Changing the model

The following steps are required to change the currently used model (following explains how to change between two models provided within InBalance package – from **sample_manual.xml** (demo model using manually entered data) to **sample_histdbase.xml** (demo model using simulated data from Historian database):

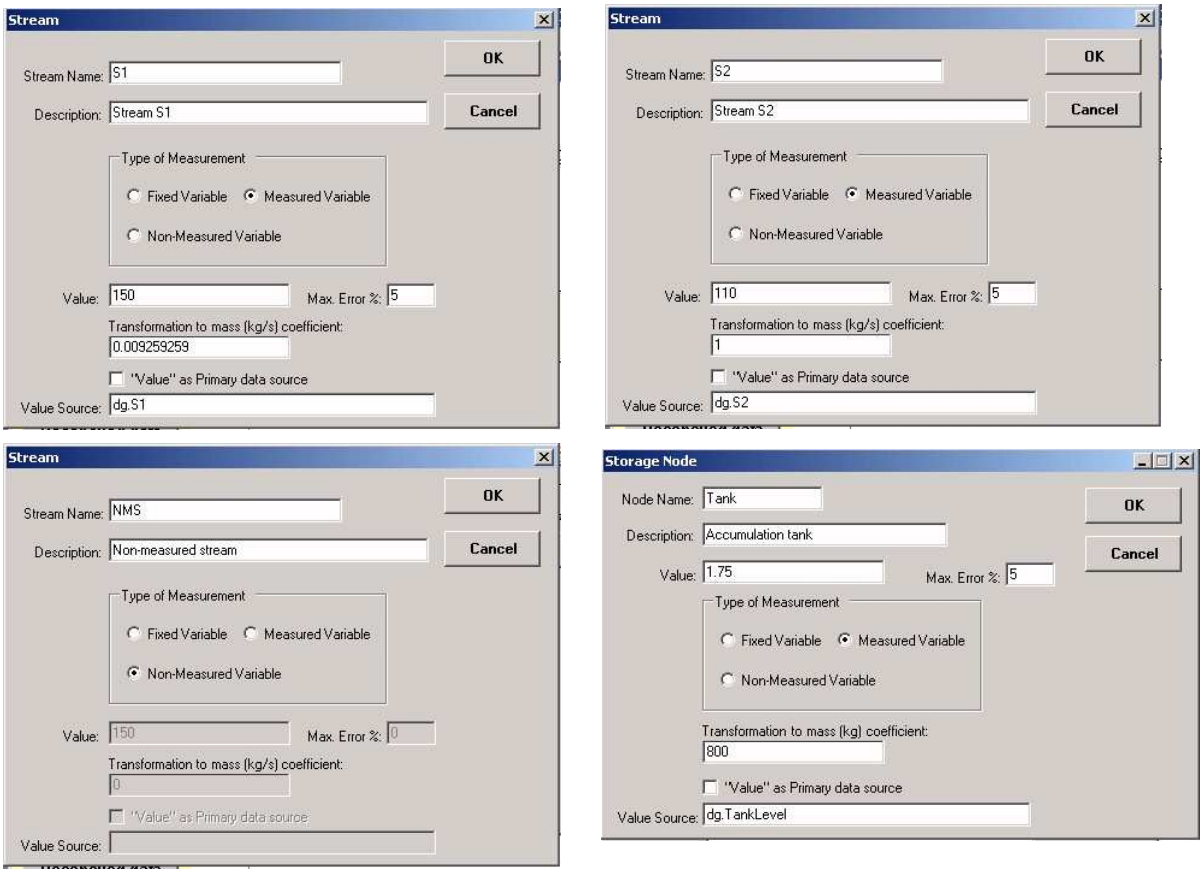
1) In InTouch – import new model in Model Editor (main menu -> File ->Import from XML…) and select sample_histdbase.xml:



2) Click “Open”. The sample_histdbase.xml demo model will appear on Model Editor window:



3) Examine the contents of streams S1, NMS, S2 and storage node Tank by double-clicking on them:

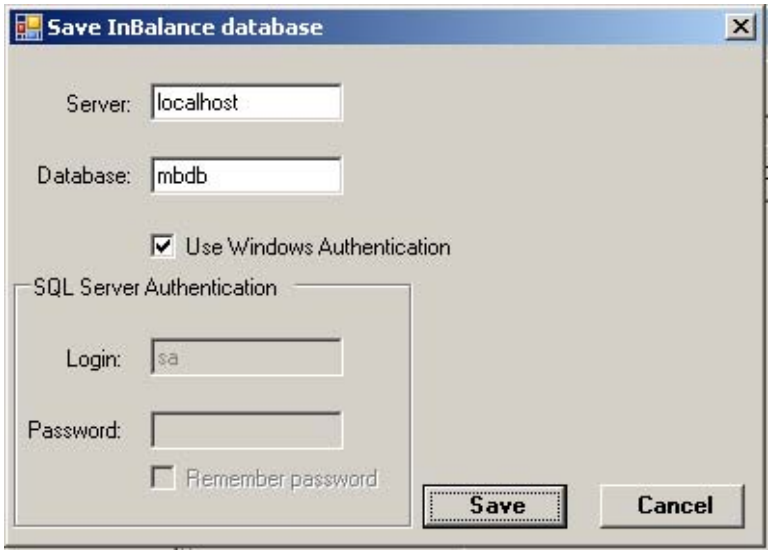


You can see streams **S1** and **S2** are measured streams, **NMS** is non-measured stream and **Tank** is a storage node with measured accumulation. For S1, S2 and Tank the values are taken from Historian database – correspondingly Historian tagnames dg.S1, dg.S2 and dg.TankLevel are used. For streams the measurements are flow rates and for storage node the measurements are storage amounts (total volume at measurement time).

In this demo model all stored in Historian database measured data is in **m3/day** (for streams) and in **m3** (for storage node), so transformation to **kg/s** (for streams) and to **kg** (for storage node) is required for calculation:

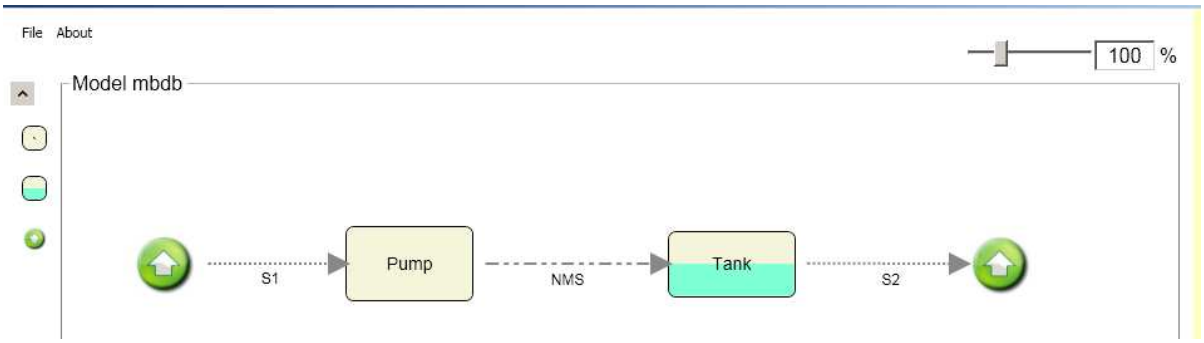
The transformation to mass coefficient is implemented the following way:
- for stream **S1** it is entered directly in “Stream” configuration dialog equal to 0.009259259, according to following formula: = density /24 /3600 (where density is 800kg/m3);
- for stream **S2** the default coefficient 1 is used and transformation to mass coefficient is calculated in object script according to same formula as above for stream S1 (see *Transformation to mass (kg/s or kg) coefficient* section later in this manual);
- for non-measured stream **NMS** the transformation to mass coefficient is calculated in object script same way as for stream S2;
- for storage node **Tank** it is entered directly in “Storage Node” configuration dialog an it is equal to 800 – assuming density is 800kg/m3.

4) Save model current configuration to internal MS SQL database (from Model Editor main menu -> File -> Save...):



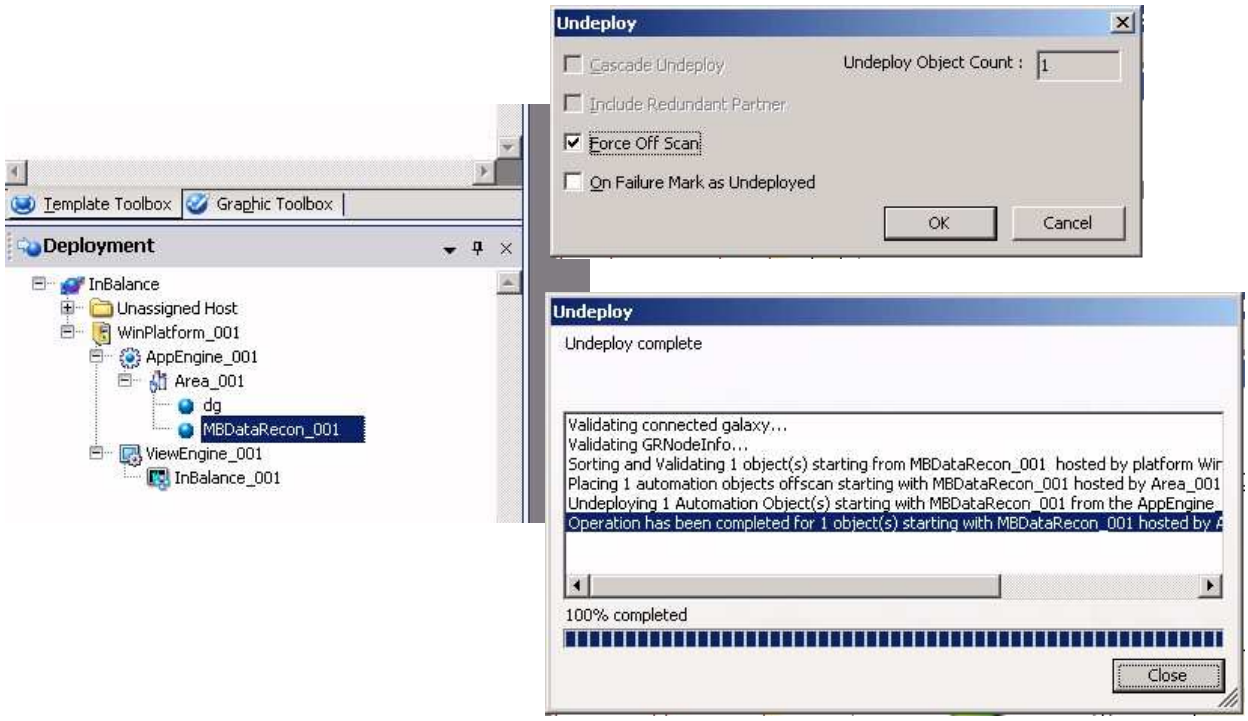
Note:
To create model database, you need to logon to MS SQL with user that have rights to create a database, since a new MS SQL database will be created that is used to store the model.

After clicking “Save”, the current database name “mbdb’ will be displayed on Model Editor window:

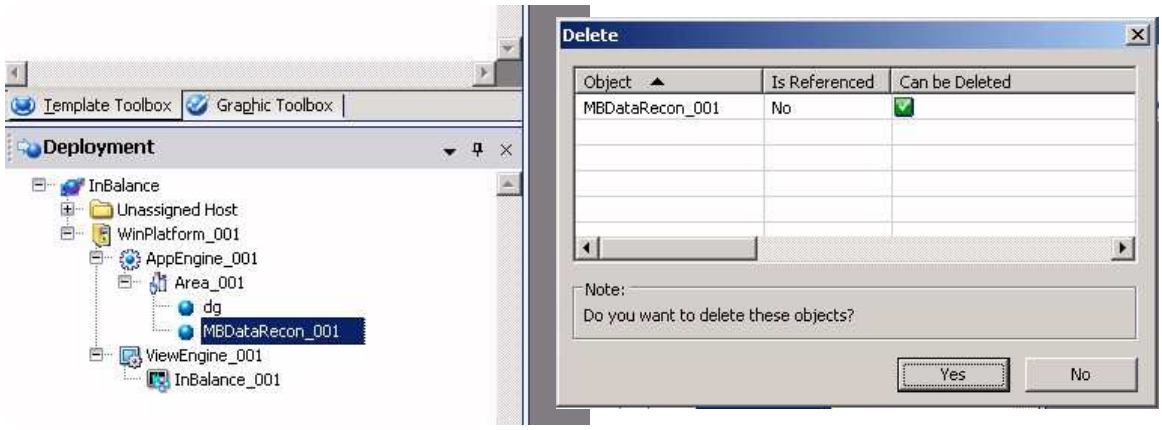


4) Start Archestra IDE (in case not yet started).

5) Undeploy MBDataRecon_001 object:

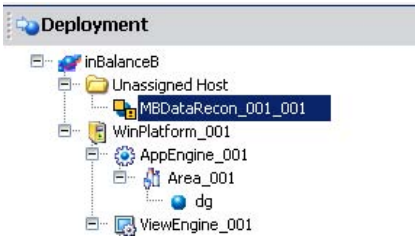


6) Delete the “MBDataRecon” instance from Deployment:

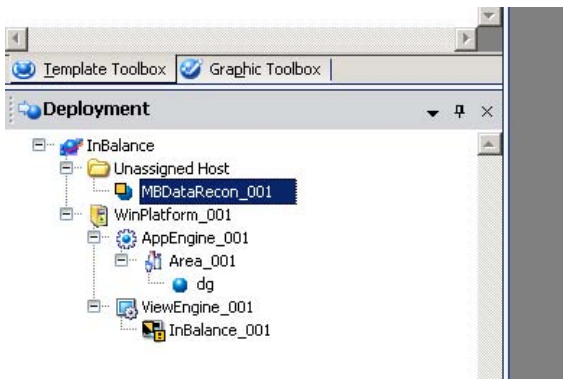


7) Create new instance by selecting **$MBDataRecon_001** in IDE Template Tollbox “InBalance” Toolset and then by selecting “New” and “Instance” from drop-down menu:

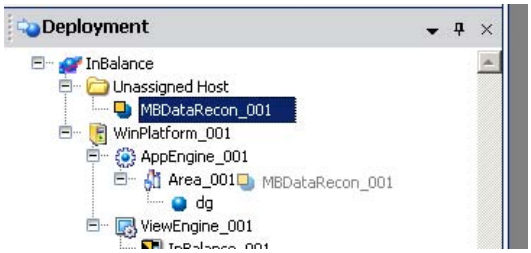
The new MBDataRecon_001_001 instance will be added to Unassigned Host.



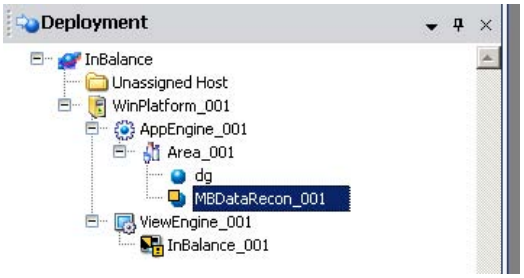
Rename it to MBDataRecon_001:



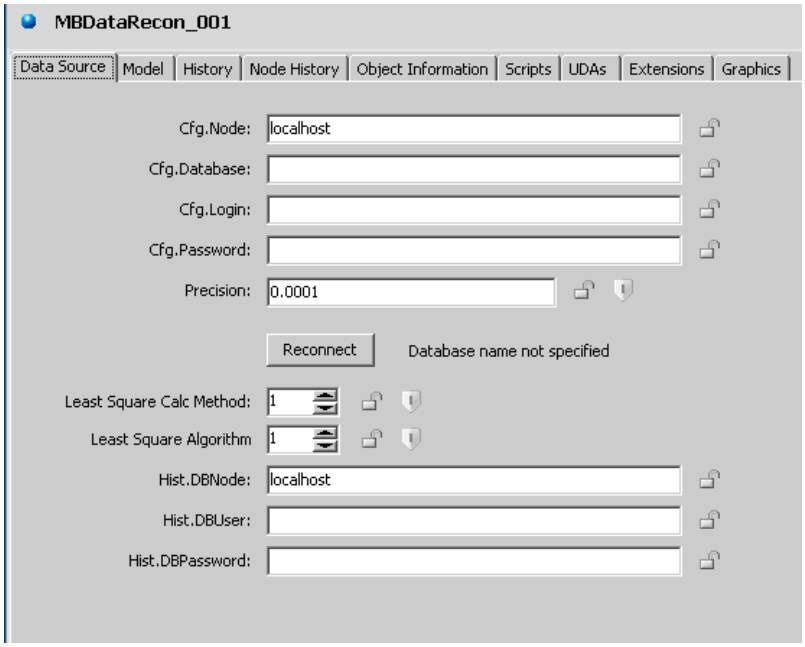
8) Drag-drop MBDataRecon_001 instance to Area_001:



The MBDataRecon_001 is added to Area_001:



9) Open MBDataRecon_001 object configuration editor:



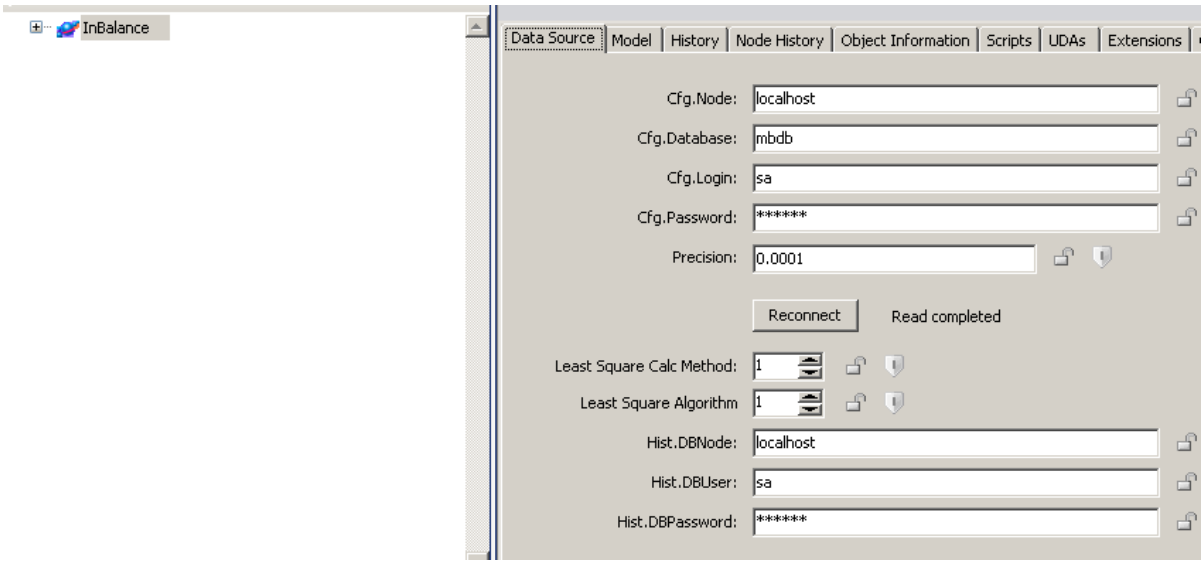
10) In “Cfg.Node” field enter the computer name where InBalance internal MS SQL database is located, in “Cfg.Database” field enter the model database name (“mbdb” in our case), in “Cfg.Login” and “Cfg.Password” fields enter the MS SQL Server username and password.

As in this model the simulated data from Historian (InSQL) database is used, it is necessary to configure also the following settings:

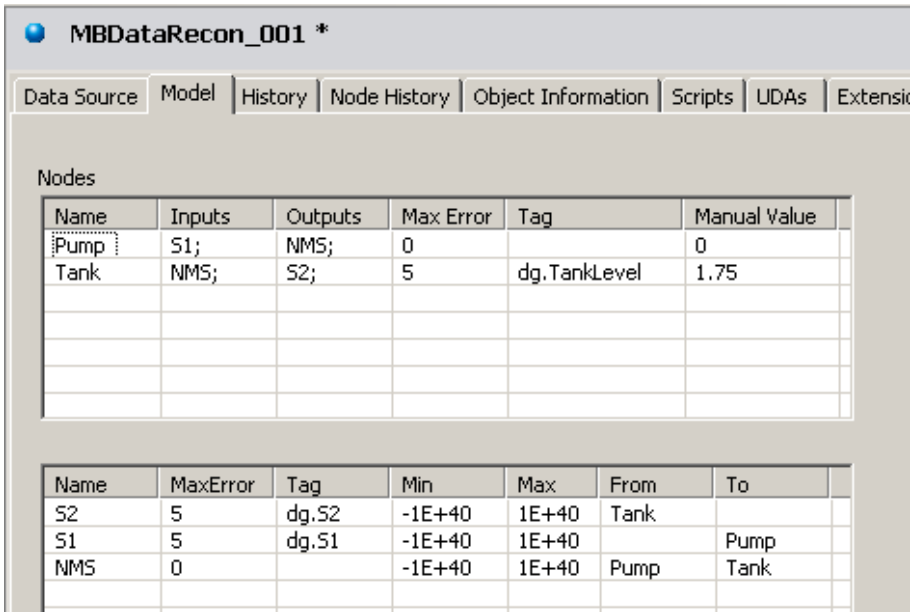
Hist.DBNode
Computer node name where Historian (InSQL) database with simulated data is located.

Hist.DBUser and Hist.DBPassword
The user name and pasword for accessing the Historian (InSQL) database with simulated data.

Press “Reconnect” button to read the model configuration from internal MS SQL database:



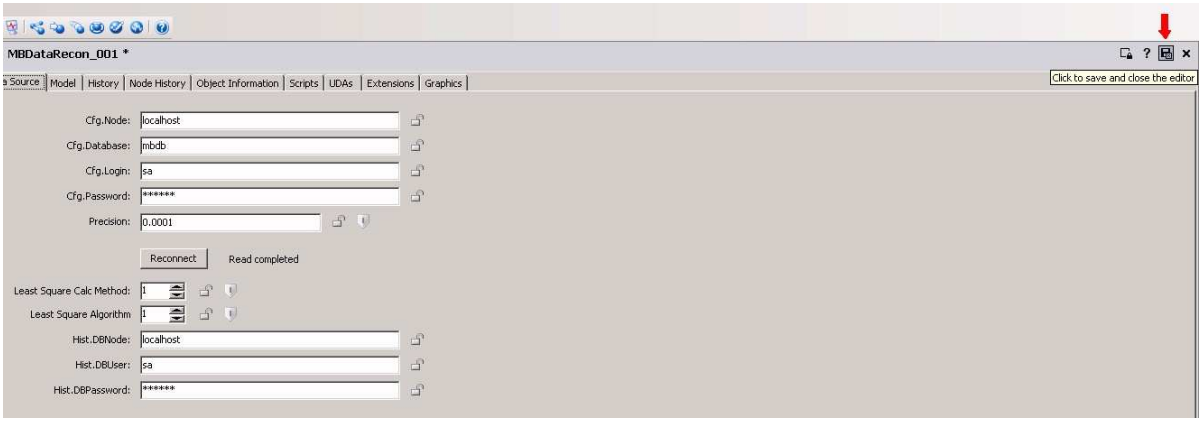
11) Check if model is loaded correctly – select the Object Editor “Model” tab:



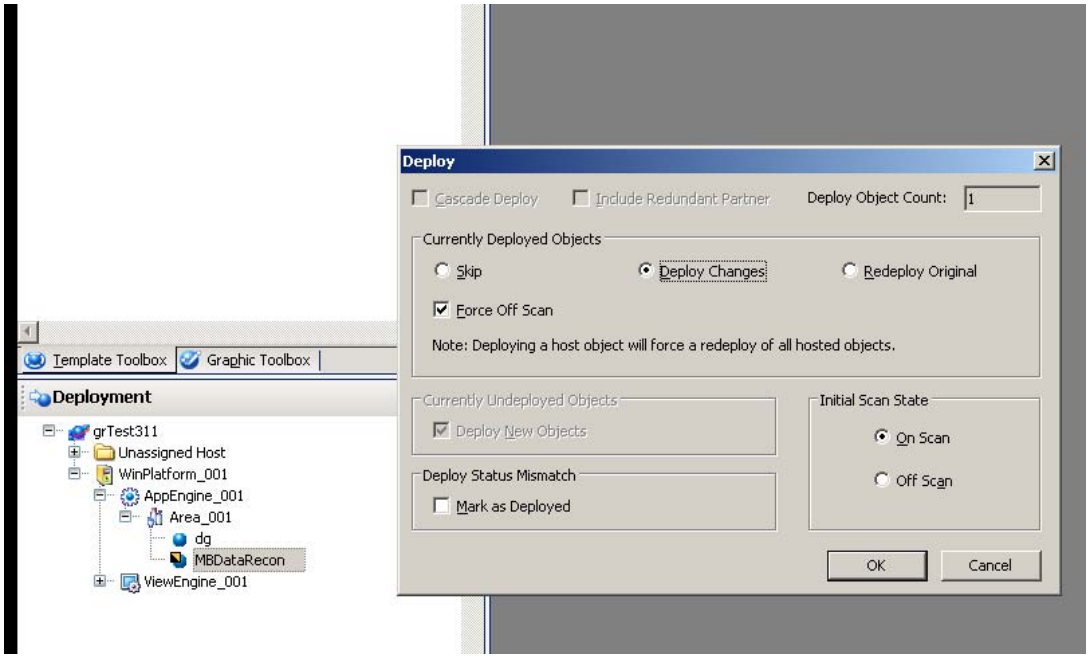
You should see Historian tagnames dg.S1, dg.S2 and dg.TankLevel for streams S1 and S2 and stotage node Tank. If there are no any nodes and streams loaded then check “Data source” tab configuration and Wonderware (SMC) logger for possible reason.

12) In purpose to be able to invoke the MS Excel with simple mass balance report (this report supports also the sample_histdbase.xml model), it is necessary to enable appropriate “History extensions” at “History” and “Extensions” tabs – completely same way as explained in *Getting started by using “sample_manual.xls” model* section (step 8) upper in this manual.

13) Save and close the current “MBDataRecon” object configuration by clicking on Close/Save icon located at right upper corner of Object Editor:



14) Deploy “MBDataRecon” object:



15) Return to InTouch. The sample_manual.xml demo model now is loaded and ready for use. The data reconciliation, mass balance calculation, visualization and reporting of results is done from InTouch “InBalance Demo” window:

InBalance technical details

MBDataRecon object description

1) General attributes:

Attribute	Data Type	Access Type	Description
Calc.Duration	Elapsed Time	Calculated	Calculation time interval (Calc.TimeEnd - Calc.TimeStart)
Calc.Iterations	Integer	Calculated	Number of iterations executed to found least squares
Calc.LeastSquare	Double	Calculated	Contains the minimum least squares value found
Calc.LsqAlgorithm	Integer	CFG Runtime	Least squares method minimum finding; 0 – searches minimum for streams separately; 1 (default) – searches minimum for all streams
Calc.LsqMethod	Integer	Cfg Runtime	Method what to minimize by least squares method: 0 – minimizes absolute difference between measured and reconciled data; 1 (default) – minimizes relative difference between measured and reconciled data
Calc.Precision	Double	Cfg Runtime	Least squares calculation precision (default - 0.0001)
Calc.Progress	Double	Calculated	Indicates calculation progress in percents (this is not percents of estimated calculation time)
Calc.RowCount	Integer	Calculated	Indicates total number of Historian values within defined time interval
Calc.Solvable	Boolean	Calculated	Indicates if model is solvable: True – yes, False – no; model is not solvable if non-measured values cannot be calculated
Calc.Status	String	Calculated	Indicates the current state of reconciliation
Calc.SwKey	String	Cfg Runtime	Software license string (not yet implemented in beta release)
Calc.TimeEnd	Time	Runtime	Calculation interval end date/time
Calc.TimeStart	Time	Runtime	Calculation interval start date/time
Calc.TotalMeasAccum	Double	Calculated	System total measured accumulated mass in kg (sum of measured mass in all Storage Nodes)
Calc.TotalMeasInput	Double	Calculated	System total measured input in kg
Calc.TotalMeasOutput	Double	Calculated	System total measured output in kg

Calc.TotalRecAccum	Double	Calculated	System total reconciled accumulated mass in kg (sum of reconciled mass in all Storage Nodes)
Calc.TotalRecInput	Double	Calculated	System total reconciled input in kg
Calc.TotalRecOutput	Double	Calculated	System total reconciled output in kg
Calc.Trigger	Boolean	Runtime	Setting to True starts the calculation, setting to False cancels the calculation; change back to False indicates the calculation process is complete.
Cfg.DBName	String	CFG	Internal MS SQL database name containing the configuration made by graphic editor (.NET Control)
Cfg.DBNode	String	CFG	Computer node name where internal MS SQL database is located
Cfg.DBPassword	String	CFG	User name for accessing internal MS SQL database
Cfg.DBUser	String	CFG	Password for accessing internal MS SQL database

2) Node attributes:

Attribute	**Data Type**	**Access Type**	**Description**
Node.InputMass	Double[]	Calculated	Array of total mass in kg for each input stream
Node.InputStreams	String[]	Calculated	Array of names of all input streams
Node.OutputMass	Double[]	Calculated	Array of total mass in kg for each output stream
Node.OutputStreams	String[]	Calculated	Array of names of all output streams
Node.Solvable	Boolean	Calculated	Indicates possibility of finding value for all connected streams (True – yes, False –no)
Node.TotalMeasInput	Double	Calculated	Node total measured input mass in kg
Node.TotalMeasOutput	Double	Calculated	Node total measured output mass in kg
Node.TotalRecInput	Double	Calculated	Node total reconciled input mass in kg
Node.TotalRecOutput	Double	Calculated	Node total reconciled output mass in kg

The following additional attributes are created for **Storage Nodes** only:

Attribute	**Data Type**	**Access Type**	**Description**
Node.Meas.AverageVal	Double	Calculated	Average accumulation (in kg) for

ue			defined time interval (for manually entered measurement = Node.Meas.MeasuredMass)
Node.Meas.BadValueCount	Integer	Calculated	Number of Historian values with bad quality or out of range (within defined time interval)
Node.Meas.Category	String	Calculated	Indicates text representation of storage node category (e.g. “measured”)
Node.Meas.ConfidenceInterval	Double	Calculated	Confidence interval for measured accumulation (= Node.Meas.ReconMass * Node.Meas.ReconError)
Node.Meas.EndValue	Double	Calculated	Last stored in Historian measured value (in kg) for defined time interval (for manually entered measurement = Node.Meas.MeasuredMass)
Node.Meas.Failed	Boolean	Calculated	Indicates impossibility to calculate non-measured accumulation (True – yes (impossible) , False –no (possible))
Node.Meas.FirstValueTime	Time	Calculated	Contains the date/time for Node.Meas.StartValue (for manually entered measurement = Calc.TimeStart)
Node.Meas.GoodValueCount	Integer	Calculated	Indicates the number of good measured values stored in Historian within defined time interval
Node.Meas.GrossError	Boolean	Calculated	Indicates gross error detected for this storage node: True – yes , False – no
Node.Meas.HistorianTagname	String	Cfg	Historian tagname used to store measured data for this storage node
Node.Meas.LastValueTime	Time	Calculated	Contains the date/time for Node.Meas.EndValue (for manually entered measurement = Calc.TimeEnd)
Node.Meas.ManualEnteredValue	Double	Cfg Runtime	Manually entered value of accumulation, constant for defined time interval (if not in kg then Node.Meas.TransfCoef to be used to enable proper transformation to kg)
Node.Meas.MaxError	Double	Cfg Runtime	Defines measurement precision of accumulation (in %)
Node.Meas.MaxLimit	Double	Cfg Runtime	Defines highest limit of accumulation valid measurements
Node.MaxValue	Double	Calculated	Contains highest measured value with good quality (for manually entered measurement =

			Node.Meas.MeasuredMass)
Node.Meas.MeasuredMass	Double	Cfg Runtime	Measured total accumulation (in kg) for defined time interval (= Node.Meas.EndValue - Node.Meas.StartValue)
Node.Meas.MinLimit	Double	Calculated	Defines lowest limit of accumulation valid measurements
Node.Meas.MinValue	Double	Calculated	Contains lowest measured value with good quality (for manually entered measurement = Node.Meas.MeasuredMass)
Node.Meas.QualityPercents	Double	Calculated	Indicates share (in %) of values with good quality within defined time interval
Node.Meas.ReconError	Double	Calculated	Reconciliation error for this storage node (in %)
Node.Meas.ReconMass	Double	Calculated	Reconciled accumulation for defined time interval (kg)
Node.Meas.StartValue	Double	Calculated	First stored in Historian measured value (in kg) for defined time interval (for manually entered measurement = Node.Meas.MeasuredMass)
Node.Meas.TransfCoef	Double	Cfg Runtime	Transformation to mass (kg) coefficient, used in case values are not in kg
Node.Meas.TypeOfMeasurement	Integer	Cfg Runtime	Type of measurement. 0 - fixed, 1 - measured, 2 – non-measured, 3 – manual/measured
Node.Meas.ValueCount	Integer	Calculated	The total number of Historian measured values within defined time interval for this storage node
Node.Meas.Variation	Double	Calculated	Indicates variation (instability from average) of measured values (in %)

3) Stream attributes:

Attribute	**Data Type**	**Access Type**	**Description**
Stream.Meas.AverageValue	Double	Calculated	Average measured flow in kg/s (= Stream.Meas.MeasuredMass / defined time interval)
Stream.Meas.BadValueCount	Integer	Calculated	Number of Historian values with bad quality or out of range (within defined time interval)
Stream.Meas.Category	String	Calculated	Indicates text representation of stream category (e.g.

			"measured/calculated")
Stream.Meas.ConfidenceInterval	Double	Calculated	Confidence interval for measured total mass passed through stream within defined time interval
Stream.Meas.EndValue	Double	Calculated	Last stored in Historian measured value (in kg/s) for defined time interval for this stream
Stream.Meas.Failed	Boolean	Calculated	Indicates impossibility to calculate non-measured value (True – yes (impossible) , False –no (possible))
Stream.Meas.FirstValueTime	Time	Calculated	Contains the date/time for Stream.Meas.StartValue
Stream.Meas.GoodValueCount	Integer	Calculated	Indicates the number of good measured values stored in Historian within defined time interval
Stream.Meas.GrossError	Boolean	Calculated	Indicates gross error detected for this stream: True – yes , False – no
Stream.Meas.HistorianTagname	String	Cfg	Historian tagname used to store measured data for this stream
Stream.Meas.LastValueTime	Time	Calculated	Contains the date/time for Stream.Meas.EndValue
Stream.Meas.ManualEnteredValue	Double	Cfg Runtime	Manually entered value of measured flow, constant for defined time interval (if not in kg/s then Stream.Meas.TransfCoef to be used to enable proper transformation to kg/s)
Stream.Meas.MaxError	Double	Cfg Runtime	Defines measurement precision of stream (in %)
Stream.Meas.MaxLimit	Double	Cfg Runtime	Defines highest limit of stream valid measurements
Stream.MaxValue	Double	Calculated	Contains highest measured value with good quality
Stream.Meas.MeasuredMass	Double	Cfg Runtime	Measured total mass passed through stream within defined time interval (in kg)
Stream.Meas.MinLimit	Double	Calculated	Defines lowest limit of stream valid measurements
Stream.Meas.MinValue	Double	Calculated	Contains lowest measured value with good quality
Stream.Meas.QualityPercents	Double	Calculated	Indicates share (in %) of values with good quality within defined time interval
Stream.Meas.ReconError	Double	Calculated	Reconciliation error for this stream (in %)
Stream.Meas.ReconMass	Double	Calculated	Reconciled total mass passed

			through stream within defined time interval (kg)
Stream.Meas.StartValue	Double	Calculated	First stored in Historian measured value (in kg/s) for defined time interval for this stream
Stream.Meas.TransfCoef	Double	Cfg Runtime	Transformation to mass (kg/s) coefficient, used in case values are not in kg/s
Stream.Meas.TypeOfMeasurement	Integer	Cfg Runtime	Type of measurement. 0 - fixed, 1 - measured, 2 – non-measured, 3 – manual/measured
Stream.Meas.ValueCount	Integer	Calculated	The total number of Historian measured values within defined time interval for this stream
Stream.Meas.Variation	Double	Calculated	Indicates variation (instability from average) of measured values (in %)
Stream.NodeFrom	String	Calculated	Name of source node or empty string if source is “environment” node
Stream.NodeTo	String	Calculated	Name of destination node or empty string or empty string if source is “environment” node
Stream.ReconFlow	Double	Calculated	Calculated reconciled flow in kg/s (= Stream.ReconMass / defined time interval)
Stream.ReconFlowConfInt	Double	Calculated	Confidence interval for reconciled flow (= Stream.ReconFlow * Stream.Meas.ReconError)

Note:
The following attributes are generated in case “History extension” is enabled in Archestra IDE Object Editor (see *Historization of calculation results* section later in this manual):

.Description
.EnableSwingingDoor
.ForceStoragePeriod
.InterpolationType
.RateDeadBand
.RolloverValue
.SampleCount
.TrendHi
.TrendLo
.ValueDeadBand

Transformation to mass (kg/s or kg) coefficient

For each stream (and for “Storage nodes”) there is a special **Transformation to mass (kg/s or kg) coefficient** setting used, useful in cases the measured data is not in kg/s or

kg -> the idea is to have simple way to calculate the flow rate and mass from measured data stored in Historian or from manually entered data. As well – by using such transformation coefficient, even multi-component mixtures can be supported.

For example, for streams this coefficient can be:

1 - in case measured data is already in kg/s

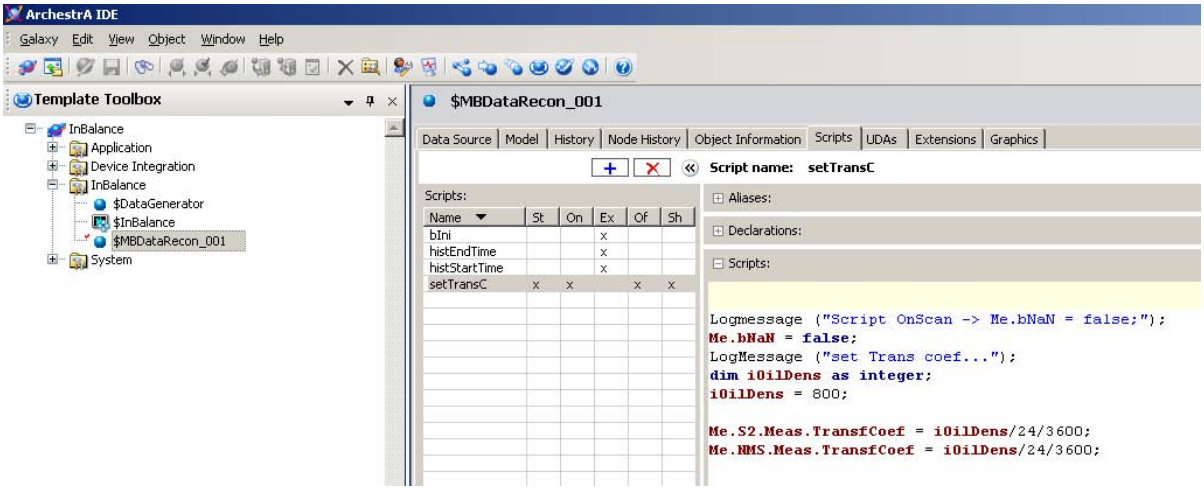
0.000277778 (= 1/3600) - in case measured data is in kg/h

0.00960648 - for mixture (measured data is in m3/day) from two components, where one component has density 1000kg/m3 and occupies 15% of total volume and another component has density 800kg/m3 and occupies 85% of total volume; in this case the transformation coefficient is calculated by following formula:
= 1000 * 0.15 + 800 * 0.85) / 24 /3600 = 0.00960648

In the demo models (sample_manual.xml and sample_histdbase.xml) and InBalance objects inclluded in InBalance iinstallation package, the measured data is in **m3/day** (for streams) and in **m3** (for storage node), so transformation to **kg/s** (for streams) and to **kg** (for storage node) is required for calculation. The transformation to mass coefficient is implemented the following way:

- for stream **S1** it is entered directly in Model Editor “Stream” configuration dialog equal to 0.009259259, according to following formula: = density /24 /3600 (where density is 800kg/m3);

- for streams **S2** and **NMS** the default coefficient 1 is used (nothing entered in Model Editor) and transformation to mass coefficient is calculated in Archestra IDE Template Toolbox $MBDataRecon_001 template script (formula is same as above for stream S1):



- for storage node **Tank** it is entered directly in Model Editor “Storage Node” configuration dialog an it is equal to 800 – assuming density is 800kg/m3.

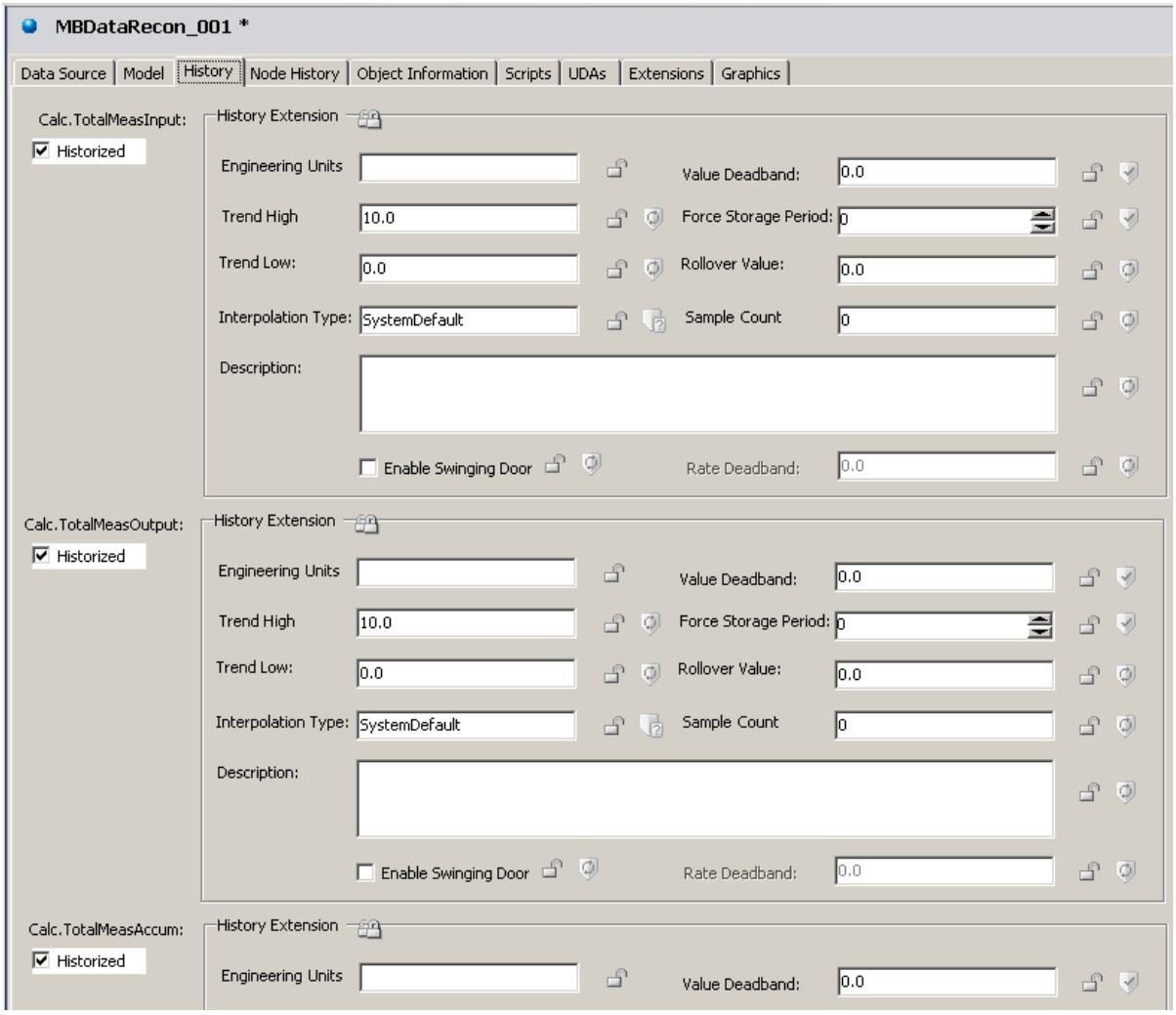
Historization of calculation results

In purpose to enable Wonderware Historian can be used as a target place to store results of calculation for further reporting and data export, the appropriate “History extensions” should be enabled when configuring the “MBDataRecon” object in Archestra IDE Object Editor.

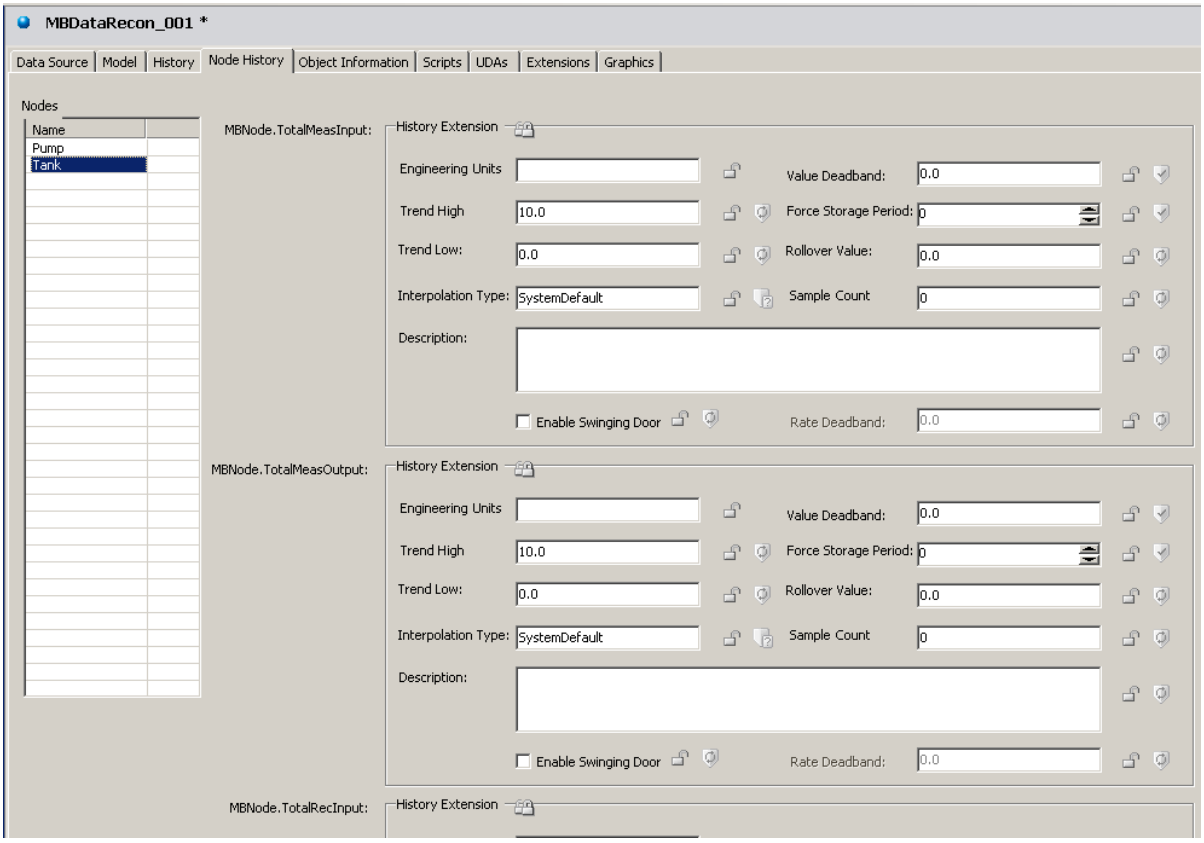
The following can be done to enable/disable the historization of calculation results:

1) In “MBDataRecon” object editor **History** tab (see below) the historization can be enabled/disabled for following attributes:

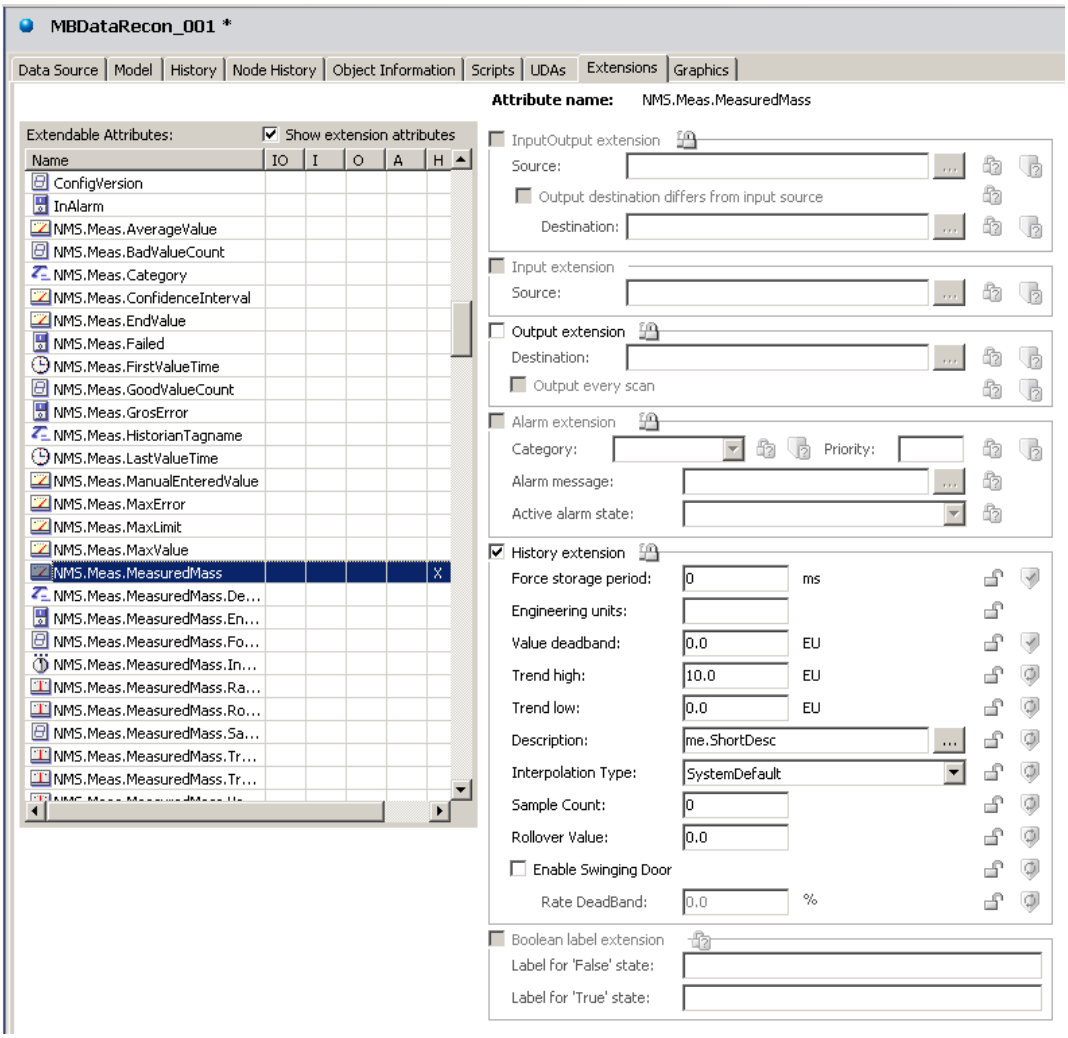
Calc.TotalMeasInput
Calc.TotalMeasOutput
Calc.TotalMeasAccum
Calc.TotalRecInput
Calc.TotalRecOutput
Calc.TotalRecAccum



2) The “MBDataRecon” object editor **Node History** tab (see below) is no more in use and will be removed in next releases:



3) For the rest of attributes the “History extensions” can be enabled in **Extensions** tab:



The simple mass balance demo report (InBalanceReport.xls) generated in InBalanceDemo application requires the following attributes have “History extensions” enabled (that is important when changing between models):

sEndTime
sStartTime

For streams S1, NMS, S1 and for node Tank:
.Meas.MeasuredMass
.Meas.ReconMass
.Meas.TransfCoef

For nodes Pump and Tank:
.TotalMeasInput
.TotalMeasOutput
.TotalRecInput
.TotalRecOutput

Note:
The “History extensions” enabled in **History** tab are not seen in **Extensions** tab.

InBalance security

InBalance solution is deeply integrated in Wonderware environment, so InBalance security level is same as implemented in Wonderware ArchestrA IDE and Wonderware Historian. Additionally InBalance has the following security features:
- audit trail functionality (not implemented in beta release): reports are created, showing who has accessed InBalance system and what operations he/she has performed during a given period of time; audit trail reports are stored in InBalance internal MS SQL database - same data base as used for configuration data interface between InBalance Model Editor and Calculation Object;

- anti counterfeit functionality, implemented automatically by Wonderware AOT (Application Object Toolkit) used to develop InBalance – all DLLs (Dynamic Link Libraries) created by AOT are automatically created as digitally signed.

Demo specific features

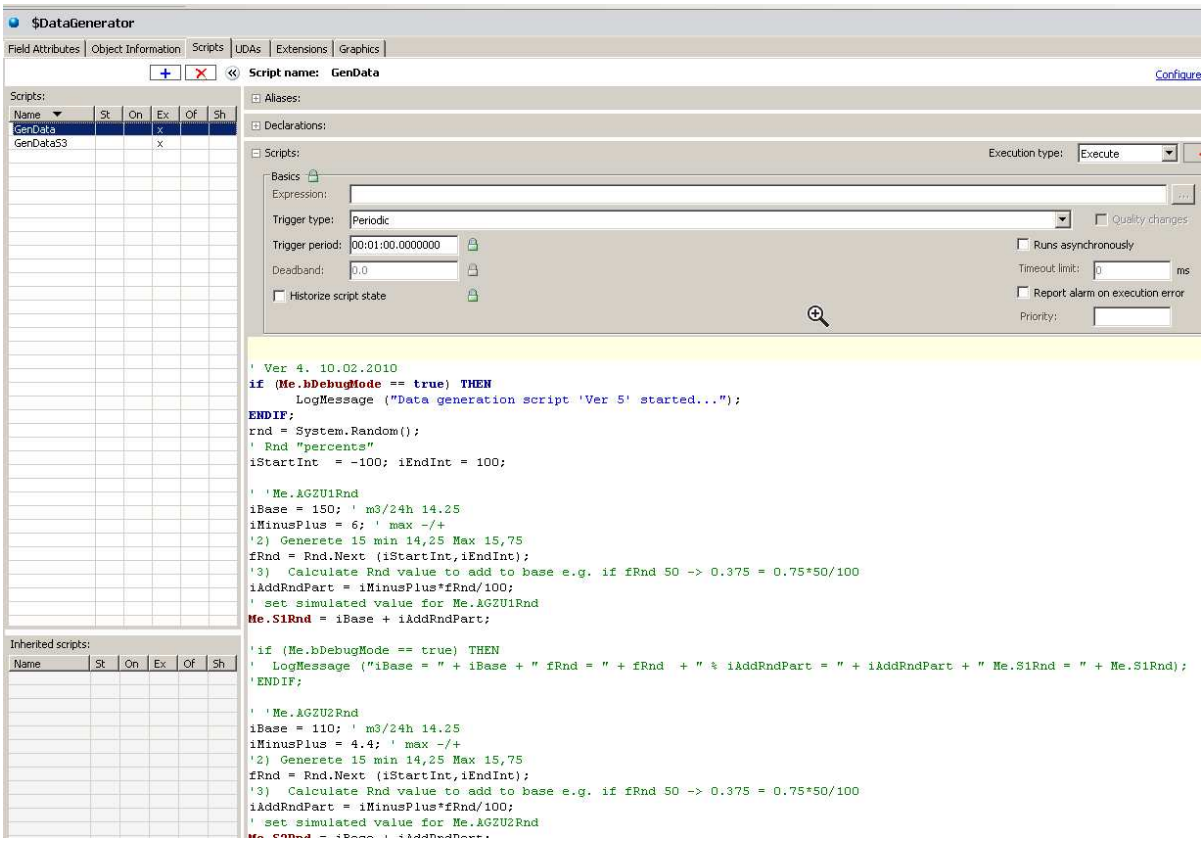
This section describes the features specific for InBalanceDemo InTouch application and simulated Historian data provided within InBalance installation package.

Data simulation

Initial simulated data for InBalance calculations is available in two ways:

1) there is available already simulated/stored “old data” for time period from 2010/02/27 00:00:00 till 2010/03/01 00:00:00;

2) new data simulation starts automatically after Historian is started and InBalance objects deployed, new data are simulated by using two object scripts **GenData** and **GenDataS3**:



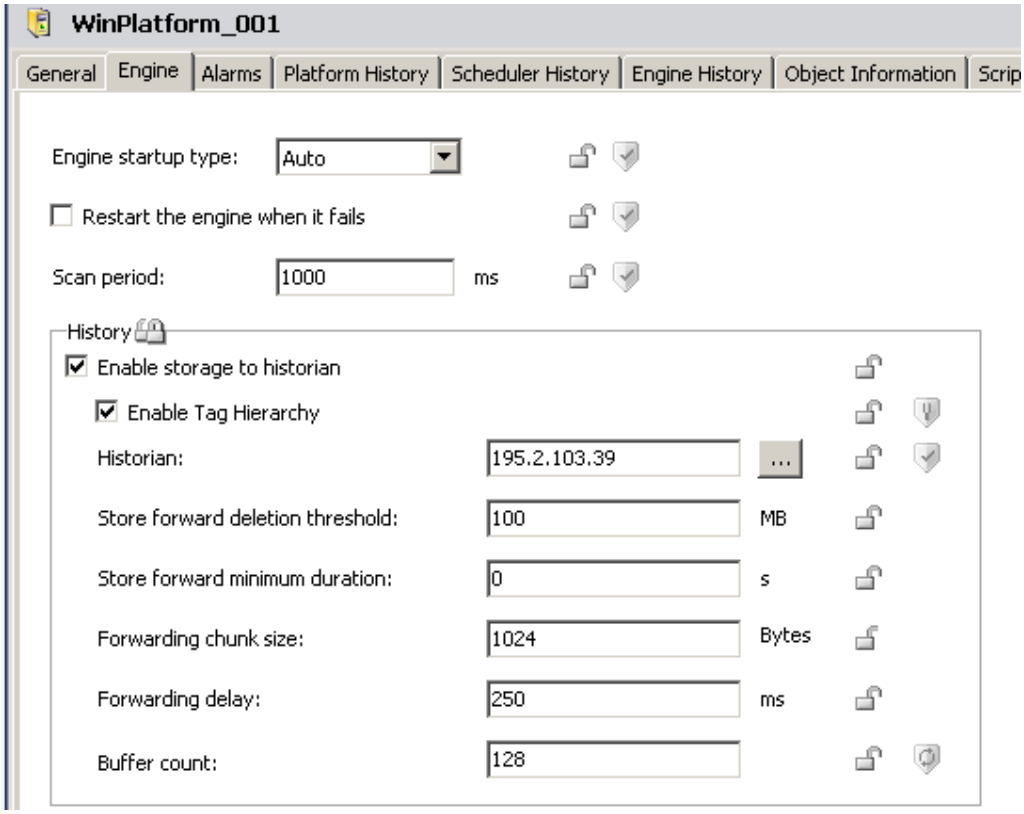
<u>For S1 and S2 (GenData script):</u>
The simulated initial data is oil volume/day e.g. 150 m3/day ± 6 m3/day of basic volume generated by .NET System.Random function.
New S1 (150 m3/day ± 6 m3/day) and S2 (110 m3/day ± 4.4 m3/day) values are simulated each 1 minute and are written to Historian database.

<u>For Tank (script GenDataS3 script)</u>

Initial value is 25 and every hour it is raised by 0.073 until after 24 hours is reaches 26.75 and then is reset back to 25.

Storing data to Historian

Data to Historian are stored by standard Wonderware Application Server interface - Historian is configured in Galaxy Platform and Engine:



Using data stored in Historian for calculation in MBDataRecon object

The MBDataRecon object performs all calculations by using simulated data (see *Data simulation* section above) stored in Historian.

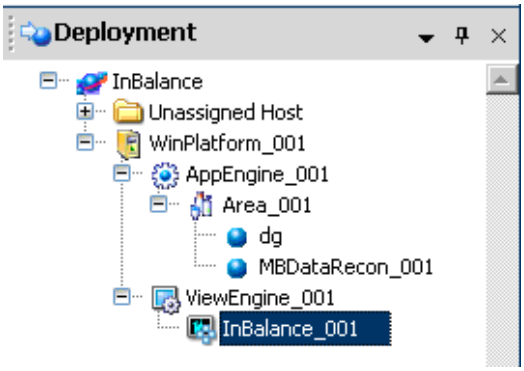
The MBDataRecon object reads data from Historian by using standard SQL queries, like the following:

SELECT TagName, Value, DateTime, QualityDetail FROM History WHERE TagName IN ({0}) AND wwRetrievalMode = 'full' AND wwVersion = 'Latest' AND DateTime >= @StartDate AND DateTime <= @EndDate ORDER BY DateTime", tag_list

This object also reads the model internal MS SQL database from specified location.

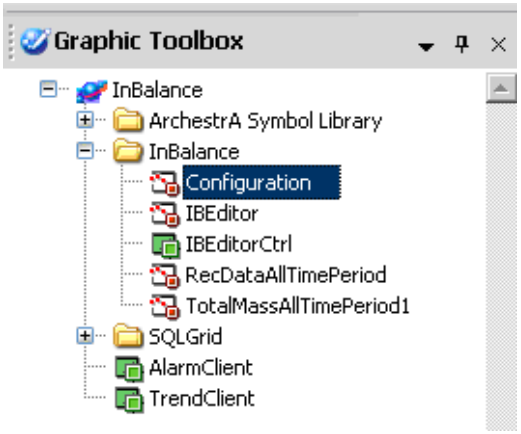
InTouchView application data visulaization

For InBalance Demo data visualization the InTouch Managed application “InBalance_001” is used:

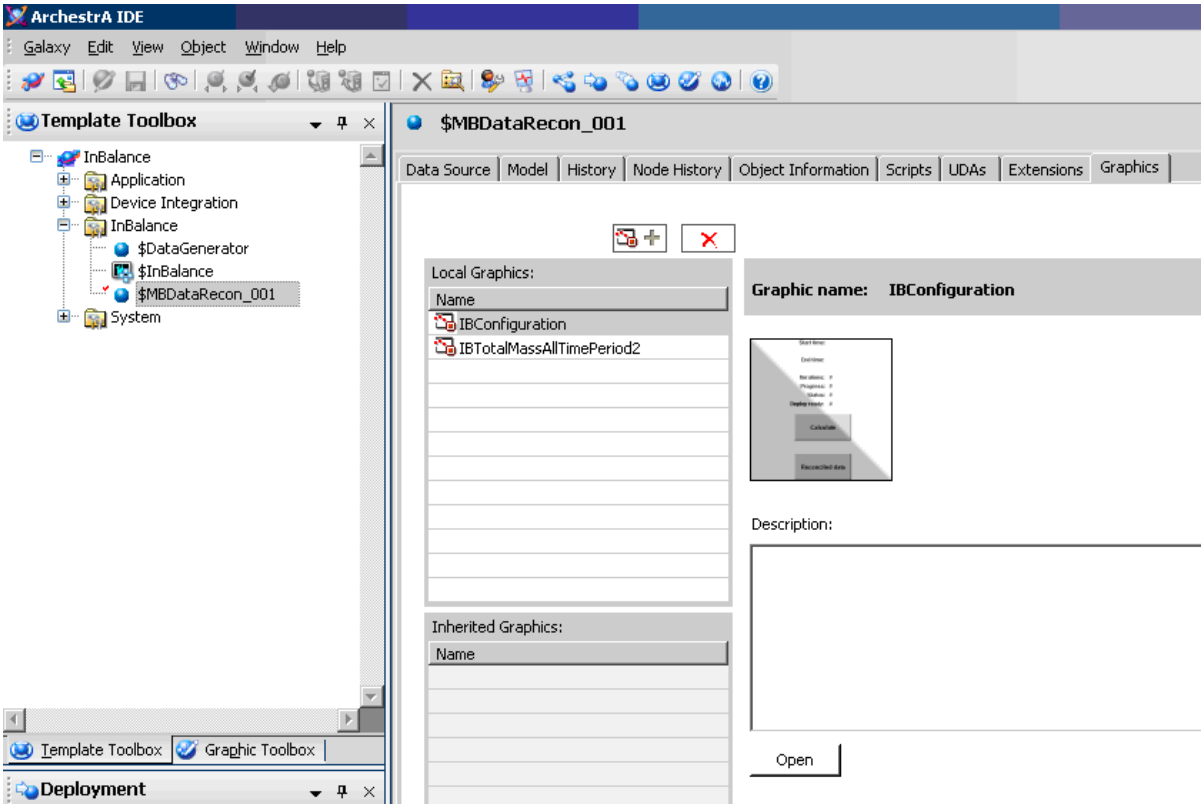


For viewing the calculated (reconciled) data and model, there are four ArchestrA Symbols (Configuration, IBEditor, RecDataAllTimePeriod and TotalMassAllTimePeriod1) used, that are displayed in InTouch application main window “InBalance Demo”.

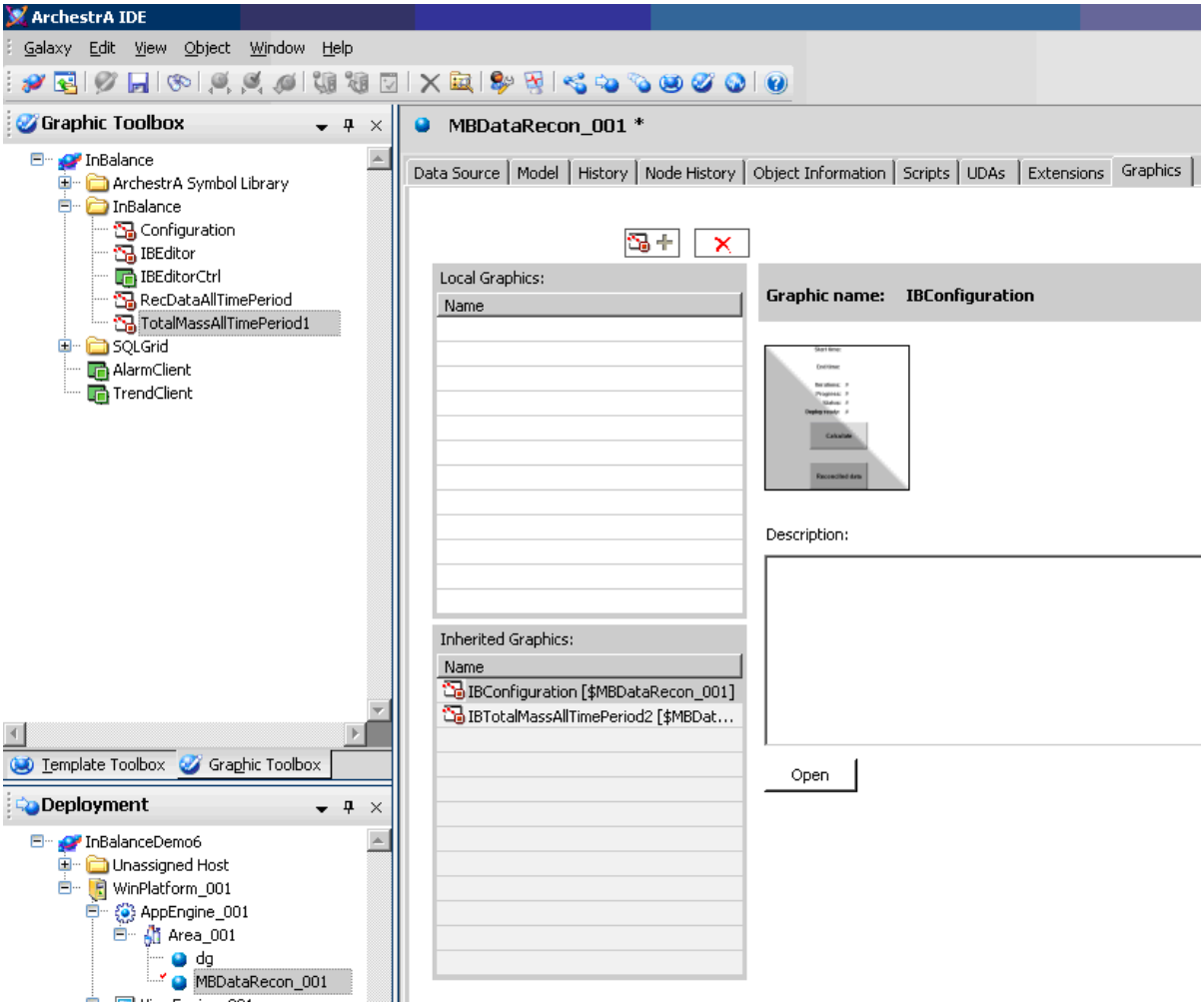
Parent Symbols are located in Graphic Toolbar under “InBalance” Graphic Toolset:



The Symbol (Configuration, TotalMassAllTimePeriod1) instances (IBConfiguration, IBTotalMassAllTimePeriod2) are located in $MBDataRecon_001 template since they display reconciled data from calculation object attributes:

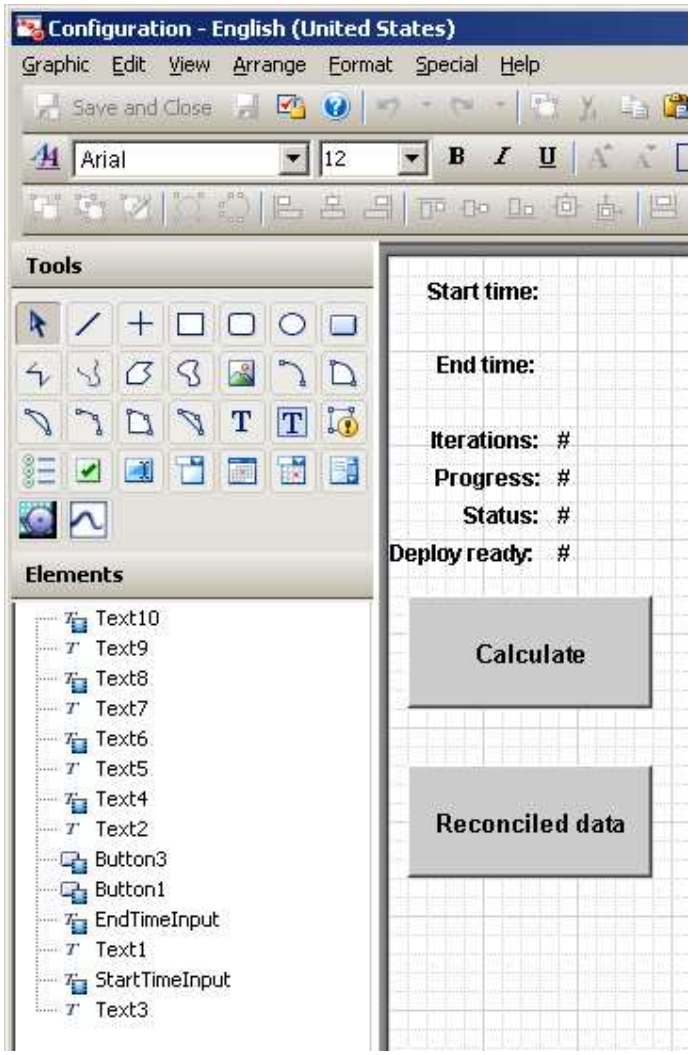


Derived from template ($MBDataRecon_001) instance (MBDataRecon_001) object contains two Inherited Graphics - (IBConfiguration and IBTotalMassAllTimePeriod2):



Description of ArchestrA Symbols

Configuration – used to set calculation interval, run the calculation and display calculation progress and results:



The “Calculate” button starts the calculation: set trigger Me.Calc.Trigger to True to start the calculation.

The “Reconciled data” button shows ArchestrA symbol that shows Reconciled data for this symbol description see section “RecDataAllTimePeriod”.

“Start time” and “End time” are used to set the calculation interval.

“Iterations” – shows the count of mathematical iterations.

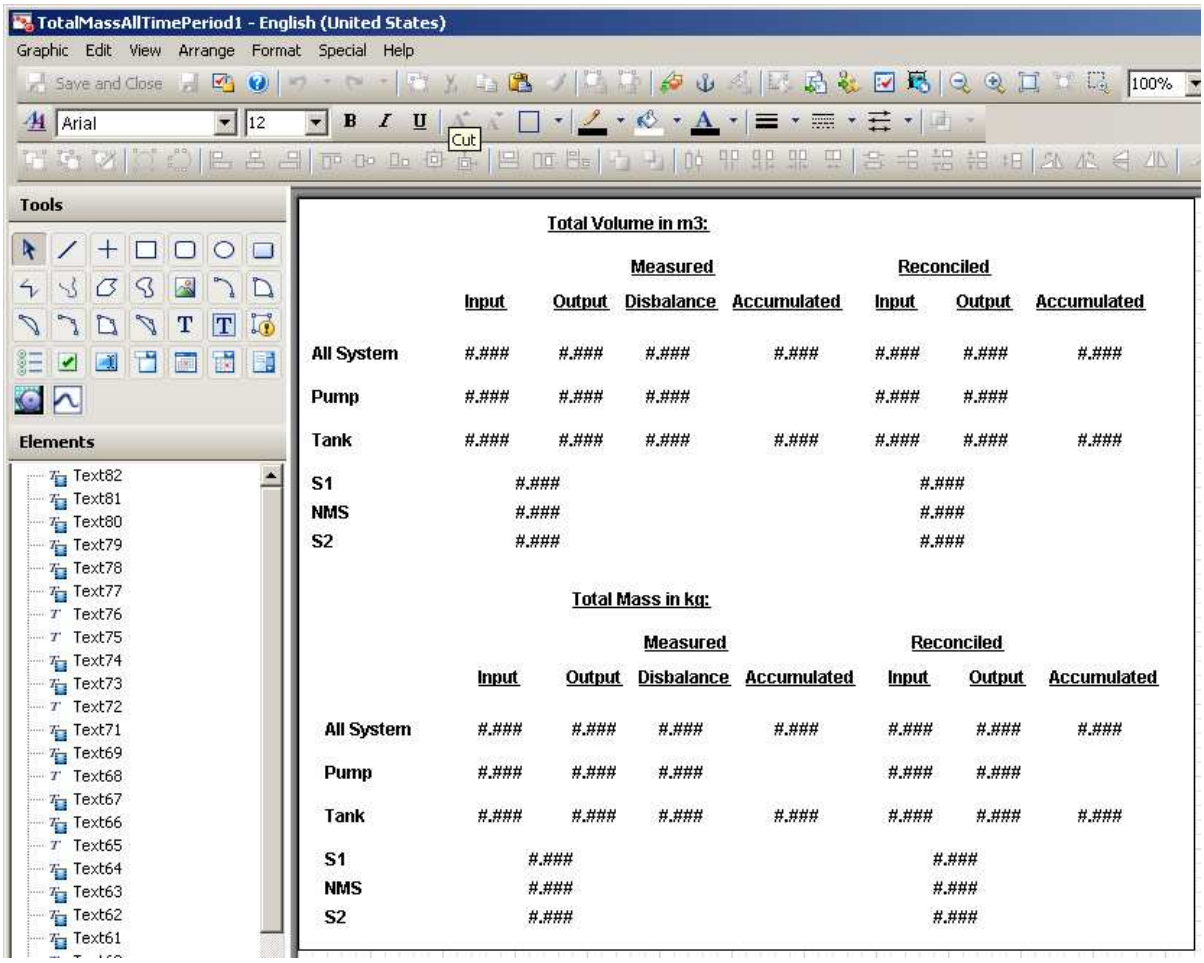
“Process” – displays calculation progress in % from 0 to 100.

“Status” – shows if object is ready for new calculation: if Me.Calc.Trigger = true then text “Not Ready” is displayed – means object is still performing the calculation); if

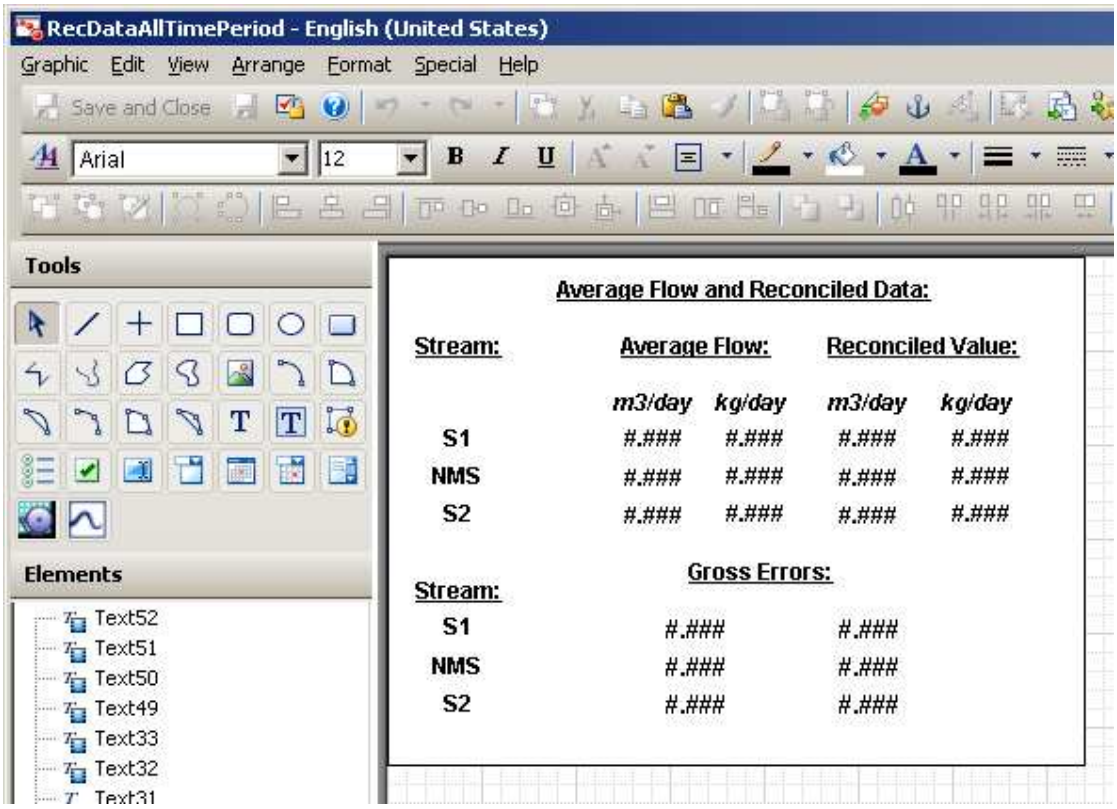
Me.Calc.Trigger = false thentext “Ready” is displayed and object is ready for new calculation

“Deploy ready” – if text is “Ready” thenobject is deployed and ready for calculation; if text “Not ready” is displayed thenobject is not deployed or is not fully initialized after deploy. jet.

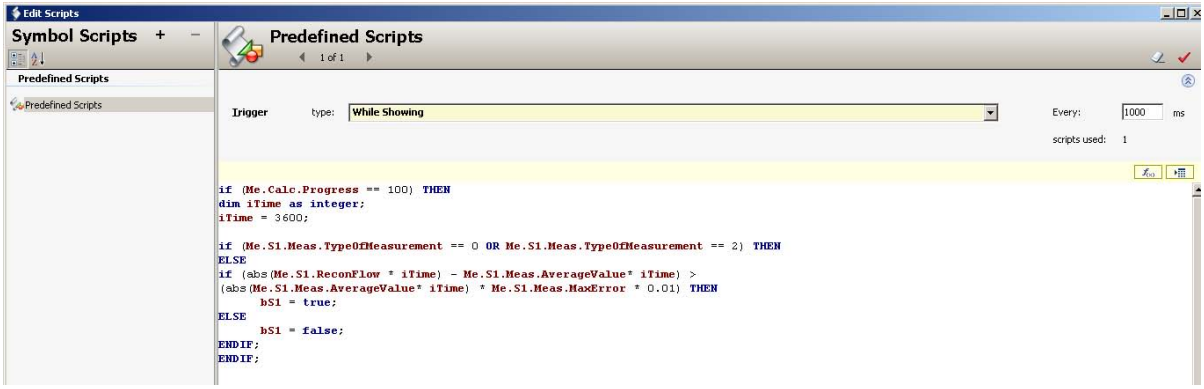
TotalMassAllTimePeriod1 - shows measured and reconciled volume (in m3) and mass (kg) for selected calculation period:



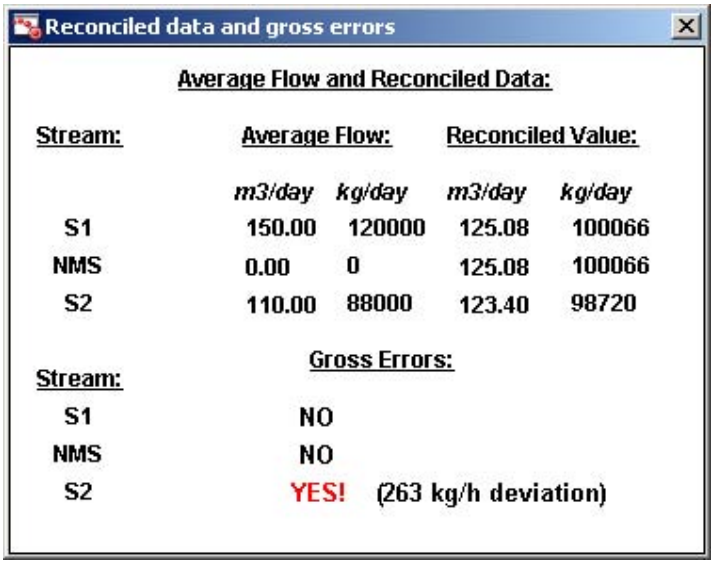
RecDataAllTimePeriod - shows measured and reconciled volume (m3/day) and mass (kg/day) and displays Gross errors if there is any detected in the model:



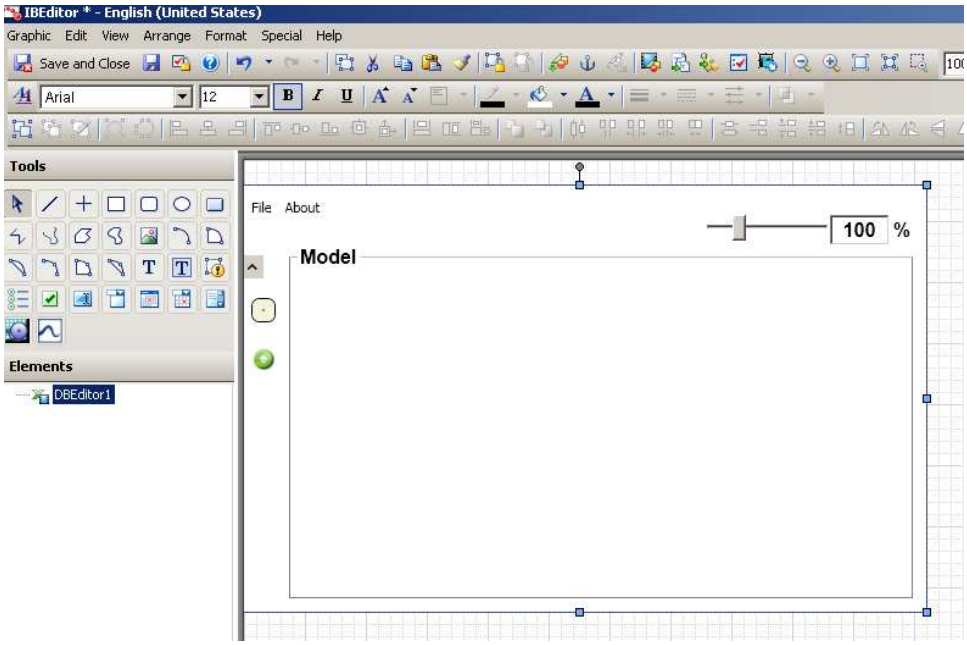
For Gross Error check logic there is ArchestrA symbol Predefined script used:



If bS1 value is true then there is Gross Error for this stream:



IBEditor – contains the Model Editor .NET control that is used in InTouch to display the model:



WONDERWARE FINLAND
InBalance Module
Revision History

Feb 2010	Rev 1.0	First Release
Mar 2010	Rev 1.1	Beta release 0.642. Beta release expiration prolonged till 16th of April 2010. The MBDataRecon object editor “Node History” tab disabled and .TotalRecInput, .TotalRecOutput, .TotalRecInput and .TotalRecOutput attributes for nodes now should be configured in ”Extensions” tab.

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